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TWO NEW SPECIES OF BOG CLUBMOSSES, LYCOPODIELLA (LYCOPODIACEAE), FROM SOUTHWESTERN MICHIGAN

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North American clubmosses and fir-mosses (Lycopodiaceae) were long neglected by botanists. Wilce's (1961) major monograph of "*Lycopodium* sect. *Complanata*" (= *Diphasiastrum* Holub) was an inspiration for further studies of this family, the members of which, like those of the Isoetaceae and Selaginellaceae, are commonly distinguished by subtle differences of kinds not familiar to flowering plant systematists. Since Wilce's publication, Bruce (1975) made a detailed study of the bog clubmosses, "*Lycopodium* subg. *Lepidotus*" (= *Lycopodiella* Holub), and Beitel initiated an extensive investigation of the gemmiferous fir-mosses (= *Huperzia* Bernh.) that has not been published. An attempt to reclassify the genera of Lycopodiaceae in accordance with standards familiar to workers in other groups of pteridophyta was made by J. Holub of Czechoslovakia (1964, 1975a, 1975b, 1983, 1985) whose proposals were rejected by most botanists. However, B. Øllgaard of Denmark (1987, 1989), in a series of elegant papers broke away from the traditional treatment of all Lycopodiaceae (except *Phylloglossum*) in a single catch-all genus *Lycopodium* and upheld several of Holub's genera, including the one used here. It now seems that evidence from many sources, including cell patterns of sporangial walls, mucilage canals in the leaves, spore sculpture, gametophyte structure and function, and chromosome numbers, amply support practically all of Holub's original proposals. Therefore, we are herewith recognizing the genus *Lycopodiella*, and we describe two new species from Michigan as belonging to this genus.

Some of main results of Bruce's research on *Lycopodiella* include the discovery that hybrids in the bog clubmosses are far more common than had been previously realized, even though Gillespie (1962) had already emphasized that hybridization was important among the species. Genus

[1]Deceased 22 January 1991.

communities of bog clubmosses may contain as many as three or four species growing together in a single habitat and they hybridize with each other, thus confusing the taxonomist. There is apparently no barrier to hybridization, and hybrids between members of the same ploidal level tend to have numerous normal-appearing spores. Bruce's conclusion was that the species of *Lycopodiella* are in an active state of evolution. The two new species described here, first suspected by Wagner and the late Dale J. Hagenah, have been amply confirmed by Bruce (1975). They are of unusual interest in being tetraploids rather than diploids, with $2n = 312$ chromosomes rather than the $2n = 156$ found in all of the other eastern American taxa, i.e. *Lycopodiella inundata* (L.) Holub, *L. appressa* (F. Lloyd & L. Underw.), *L. alopecuroides* (L.) Cranfill, and *L. prostrata* (Harper) Cranfill (Bruce 1975). Triploid hybrids (Figs. 2–4) of *L. inundata* with each of these two new species yield unusually high numbers of abortive spores. Hybrids between them, however, appear to have normal spores, as do interspecific hybrids between diploid species in eastern United States.

KEY TO DRIED SPECIMENS OF MICHIGAN LYCOPODIELLA

1. Fertile shoots mostly 3.5–6 cm tall; peduncle leaves remote; both peduncle leaves and sporophylls wide spreading ..... *L. inundata*
1. Fertile shoots mostly 7–14 cm tall; peduncle leaves close; peduncle leaves and sporophylls spreading or appressed.
   2. Peduncle and strobilus leaves appressed; strobilus 2–5 × 0.4–0.8 cm, 1.1–1.4 × as thick as leafy peduncle, and 0.2–0.6 × as long as peduncle ..... *L. subappressa*
   2. Peduncle and strobilus leaves spreading ascending; strobilus 5–8 × 0.4–0.9 cm, 1.5–2.0 × as thick as leafy peduncle, and 0.6–1.0 × as long as peduncle ..... *L. margueritae*

Lycopodiella subappressa J. G. Bruce, W. H. Wagner, and Beitel, *sp. nov.* (Fig. 1, S; Figs. 2–4).—TYPE: Michigan: Ottawa Co., borrow pit on east side of US 31, North of Grand River, 14 November 1970, *W. H. Wagner 70508* (holotype: MICH).

Habitu formam parvam Lycopodiellae appressae simulans. Folia valde appressa, strobilo quam pedunculo folioso tantum parum crassiore. Caulis erectus plerumque singularis, 7–14 × 0.3–0.7 cm, foliis 3.5–6.0 × 0.3–0.8 mm, dentibus marginalibus nullis. Strobili 2–5 × 0.4–0.8 cm, sporophyllis appressis, quam pedunculi 1.1–1.4plo crassiores.

Resembling a dwarf form of *Lycopodiella appressa*. Peduncle and strobilus leaves strongly appressed, the strobilus only slightly (0–2 mm) thicker than the leafy peduncle. Rhizome flat on ground 4–17 × 0.3 cm, the leaves vertically ascending and drying upward, 4–6 × 0.8–1.0 mm, marginal teeth none. Upright shoot 1 (rarely 2), 7–14 × 0.3–0.7 cm, the leaves 3.5–6.0 ×

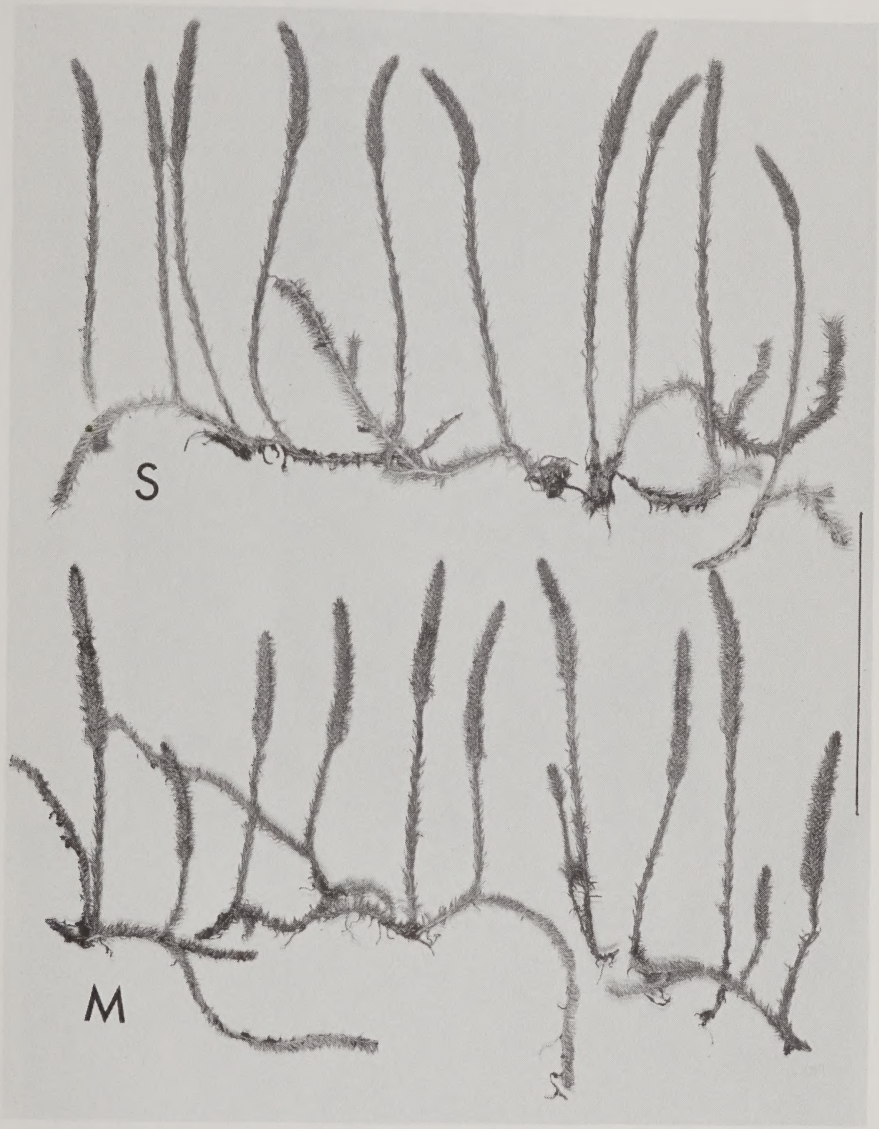

FIGURE 1. Dried specimens of two new species of bog clubmoss, *Lycopodiella*. S = *L. subappressa*. M = *L. margueritae*. Note large size and comparison of the relative development of leafy peduncle and strobilus. Scale bar = 10 cm.

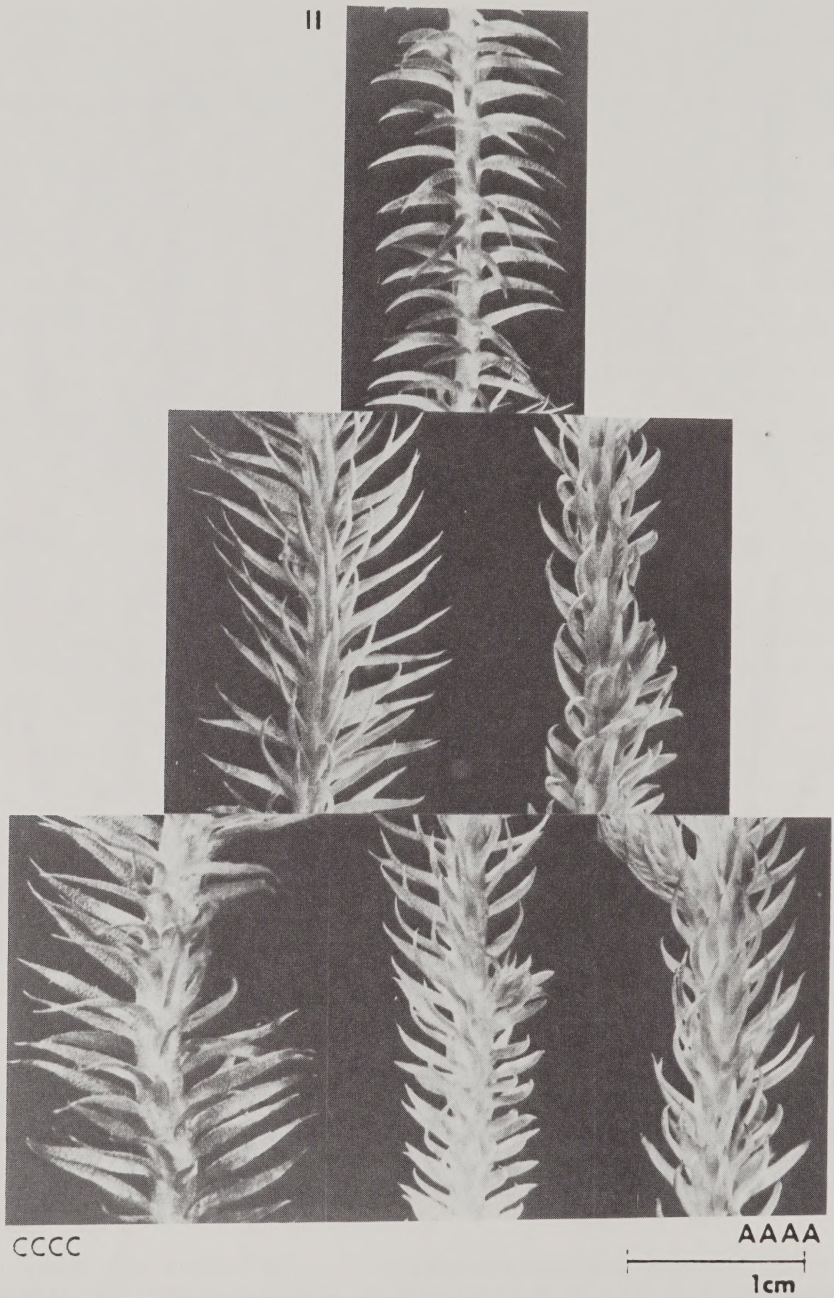

FIGURE 2. Sections of living rhizomes of species of clubmosses arranged in a triangle, with natural hybrids shown between the parental poles. AAAA = *Lycopodiella subappressa*. CCCC = *L. margueritae*. II = *L. inundata*.

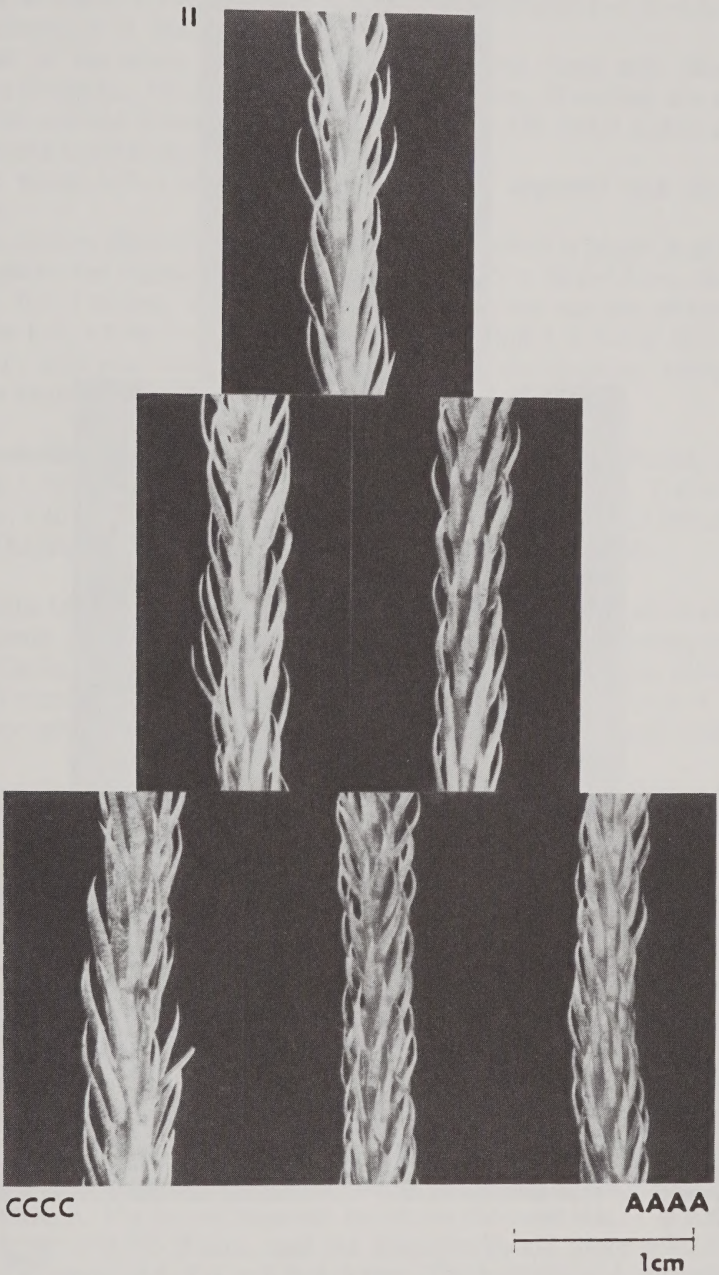

FIGURE 3. Sections of living leafy peduncles of bog clubmosses: poles of triangle = species; legs = hybrids. AAAA = *Lycopodiella subappressa*. CCCC = *L. margueritae*. II = *L. inundata*.

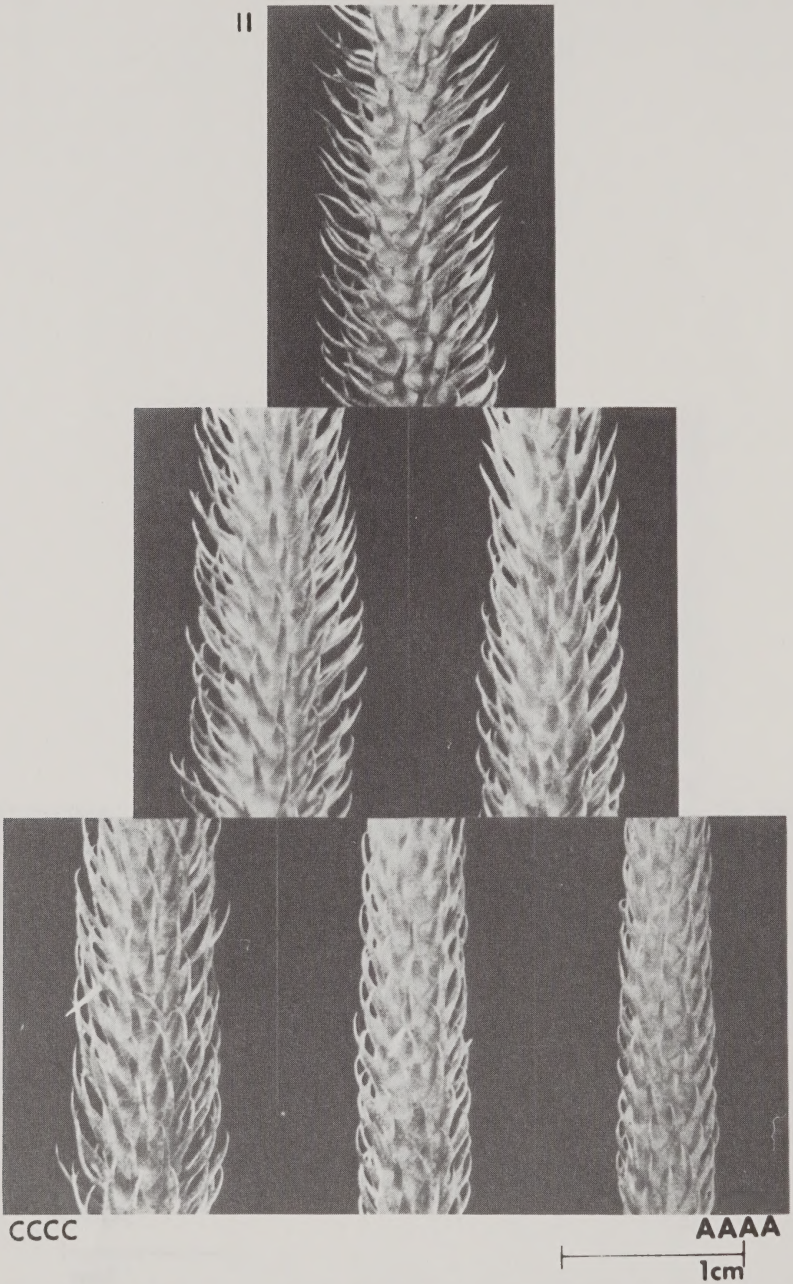

FIGURE 4. Sections of living strobili of bog clubmosses: poles of triangle = species; legs = hybrids. AAAA = *Lycopodiella subappressa*. CCCC = *L. margueritae*. II = *L. inundata*.

0.3–0.8 mm, marginal teeth absent. Strobili 2–5 × 0.4–0.8 cm, 0.2–0.6 × as long as stalk, 1.1–1.4 as wide as stalk. Sporophylls 3–4 × 0.2–0.5 cm, teeth absent. $n = 156$ (Bruce 1975).

Most of the other collections come from the same area (Berrien to Ottawa Counties, Michigan) so are not cited here. Botanists are urged to seek this and the following species, especially in the Great Lakes area and the eastern coastal plain.

The name refers to its resemblance to *L. appressa* and its smaller stature.

This species differs in size from *L. appressa* which is larger in practically all respects: the rhizome of *L. appressa* is 15–45 × 0.4–0.6 cm, the leaves 5–7 × 0.8–1.0 mm, with 0–3 marginal teeth; the upright shoots which number 1–7, 13–40 × 0.3–0.4 cm; and the strobili 2.5–6.0 × 0.3–0.4 cm. Also, *L. appressa* has a more southern main distribution, except for a narrow strip on the eastern coast, and is a diploid.

Lycopodiella margueritae J. G. Bruce, W. H. Wagner, & Beitel, *sp. nov.* (Fig. 1, M; Figs. 2–4). — TYPE: Michigan: Van Buren Co., E side of I-94, 1 mi. S of Bangor Interchange, borrow pit, just S of Route 380 deadend, 25 October 1970, *W. H. Wagner 70477* (holotype: MICH).

Habitu formam robustissimam Lycopodiellae inundatae simulans. Folia divergentia incurvataque, strobilo quam pedunculo folioso conspicue crassiore. Caulis erectus plerumque singularis, 7–14 × 0.3–0.7 cm, foliis 5–6 × 0.4–0.8 mm, dentibus marginalibus utrinque 0–2. Strobili 5–8 × 0.4–0.9 cm, sporophyllis magis patentibus, quam pedunculi 1.5–2.0plo crassiores.

Suggesting a very robust form of *Lycopodiella inundata*. Peduncle leaves spreading, the strobilus considerably thicker (2–4 mm) than the leafy peduncle. Rhizome flat on ground 10–18 × 1.0–1.6 cm, the leaves spreading and nearly perpendicular to axis, 6–13 × 0.8–1.2 mm, with marginal teeth 3–4 per side. Upright shoot 1, 7–14 × 0.3–0.7 cm, the leaves initially divergent and then incurved, almost appressed, 5–6 × 0.4–0.8 mm, marginal teeth 0–2 per side. Strobili 5–8 × 0.4–0.9 cm, 0.6–1.0 as long as stalk, 1.5–2.0 as wide as stalk, the sporophylls appressed incurved, 4–6 × 0.4–0.5 mm, apparently no teeth. $n = 156$ (Bruce 1975).

This plant is named in honor of Marguerite Bruce, whose kindly disposition and warm faith contributed so much to this study.

Lycopodiella inundata is smaller in most characters than this species: The rhizome of *L. inundata* is only 3–12 × 0.5–0.9 cm with leaves 5–6 × 0.5–0.7 mm and mostly lacking marginal teeth. The upright shoot is 3.5–6.0 × 0.4–0.7 cm. The leaves however, are about the same size. The strobili are only 10–20 × 2.5–5.5 mm, and the sporophylls are more spreading and somewhat larger, 4.5–5.0 × 0.5–9.0 mm. The hybrids of *L. inundata* with *L. margueritae* as well as *L. subappressa* are evidently sterile because of their triploid condition and its effect on the meiotic process and sporogenesis.

These new bog clubmosses should be sought not only in nearby parts of Wisconsin, Illinois, Indiana, and Ohio, but also along the eastern coastal plain. The area in which *L. subappressa* and *L. margueritae* occur is known for the presence of certain Coastal Plain disjuncts, such as *Woodwardia areolata* (S.W. Michigan and Indiana Dunes, M. Homoya, pers. comm.). We are still a long way from a full understanding of these clubmosses, and we wish to encourage field botanists to make a special effort to obtain representative collections from mixed populations. It is important to remember that a patch of these plants represents a clone, i.e. genetically identical individuals from one original plant. Thus a sterile hybrid may form 100's of individuals. The plants are actually easier to identify when they are alive and growing, rather than in the herbarium. Careful field notes can be very valuable.

ACKNOWLEDGMENTS

We wish to thank R. K. Rabeler for helpful comments on the manuscript, and W. R. Anderson for the Latin descriptions.

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ANNOUNCEMENT
THE NEW YORK FLORA ASSOCIATION
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The New York State Museum Institute is pleased to announce sponsorship of The New York Flora Association (NYFA), a new organization that will promote the study of the native and naturalized plant life of New York State. This group will serve as an information exchange for both professional and amateur botanists who are interested in New York's wildflowers, ferns, shrubs, and trees. The NYFA has been organized by Dr. Richard S. Mitchell, New York State Botanist, and Dr. Robert Zaremba of the Nature Conservancy. A 12-member Advisory Council has been appointed to oversee the use of both human and monetary resources in pursuit of the organization's goals.

NYFA members receive the NYFA Newsletter, a quarterly publication containing information on a variety of botanical issues, including saving rare plants and documenting new weeds, as well as announcements of field trips and the semi-annual meetings. Members will also receive a copy of a preliminary atlas which maps the 3500 plant species known in New York; botanists are encouraged to use it as a working document, adding to its content by identifying and reporting new populations and/or taxa. New members will also receive a copy of recent legislation involving rare plants.

Anyone interested in wild plants and where they occur in New York State is invited to join; the February 1991 NYFA Newsletter noted there are now over 300 members. Dues are $10.00 per year, plus a one-time fee of $5.00 to help pay for the 500-page atlas [a bargain by almost any calculation—Ed.]. For further information contact Dr. Mitchell at the address below. To join, send a $15.00 check made payable to: N.Y.S. Museum Institute along with your complete mailing address to:

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HERB WAGNER AND MICHIGAN BOTANY

1991 should be remembered not only as the 50th anniversary of the founding of the Michigan Botanical Club, but also as the year that Herb Wagner retired from the University of Michigan, 40 years after he joined the Botany Department. We are pleased to dedicate this number of *The Michigan Botanist* to Herb and Florence Wagner.

Herb Wagner is one of those rare people who have done so much in their career that even a small portion of his activities can be singled out for honors. We can mention that he has served as President of the Michigan Botanical Club (1968–71) and as Chairman of the Michigan Natural Areas Council (1958–59). Combine that with his contributions to our knowledge of Michigan plants, particularly ferns, and there is no need to mention that he has also been President of the American Society of Plant Taxonomists in 1966, President of The American Fern Society (1970–71), President of The Society for the Study of Evolution in 1972, and President of the Botanical Society of America in 1977. Recognition of his accomplishments also does not require mentioning that the Wagner Trees that evolutionary biologists talk about are named after their originator, Herb Wagner—not a long deceased scientist from Darwin's era. It seems anticlimactic to mention that he was elected to the National Academy of Sciences in 1985, a rare honor accorded to very few, or that he was awarded the Asa Gray Award of the American Society of Plant Taxonomists last year.

When noting Herb's contributions to Michigan Botany, no mere list of publications does justice, to say nothing of the fact that they are so numerous that we would hardly have the space to list them all. Others, of lesser stature, also have long bibliographies. What makes Herb's contributions so important? One of the major things is that Herb has shown us time and time again that we do not understand nearly as much about the flora of an area as well known as Michigan or the Great Lakes region as we might think in moments of relaxation or conceit. Many species or genera that seem simple and straightforward appear that way only because of our lack of understanding. Herb, a consummate field botanist, has not always found things so simple. He has not left us hanging, however, but has either unravelled the complexity or pointed the way for others to do so.

Just in the past few years, he and Florence have described from, or discovered in, the Great Lakes region a half dozen or so species of moonworts (*Botrychium*) new to science. Plus the two new clubmosses (*Lycopodiella*) in this issue of *The Michigan Botanist*. Plus many new hybrids, including the dogwood (*Cornus*) in the last *Botanist*. Plus many rare and interesting species, ferns, flowering plants, and bryophytes, reported new to Michigan and usually analyzed in careful detail.

Fortunately for us, Herb has not kept his vast knowledge to himself. He has unstintingly devoted a great amount of time to giving stellar lectures—performances, in fact!—to all interested groups. Probably no one has given

Herb Wagner and five of his former graduate students from the 1960's. Left to right: John Mickel, A. Murray Evans, Herb, Ronald L. Stuckey, Richard A. White, and David B. Lellinger. Photo supplied by Ronald Stuckey, taken in Ann Arbor, 27 June 1990.

as many lectures, and on so many different topics, to the various chapters of the Michigan Botanical Club as Herb. The enthusiasm he exudes, once experienced, is impossible to ignore or forget. He is always open to company on his numerous field trips, and one can't help but learn a great deal just being in the field with him. Herb also has a growing legacy of students. Although it is most appropriate that the photograph we used shows him with a number of his prominent doctoral students, perhaps Herb's greater impact is on the number of students of all ages that have developed—and continue to develop—a fresh and new appreciation of natural history from his courses and lectures.

When journals honor scientists at retirement, the focus is normally a review of distinguished past accomplishments. We prefer to note with enthusiasm the fact that freedom from academic duties will allow Herb and Florence Wagner to contribute even more to Michigan and Great Lakes botany in the future.

—Anton A. Reznicek & Richard K. Rabeler
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RICCIA FROSTII, A LIVERWORT NEW TO MICHIGAN

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The Ricciaceae known to occur in Michigan now number nine species. Previous to 1983, only two species had been recorded from the state. Those species, *Riccia fluitans* L. and *Ricciocarpos natans* (L.) Corda, curious and pleasant as they are to find, are widespread in Michigan and elsewhere in North America. From November 21 to December 7, 1982, Michael Mayfield and Marie Cole, in company with Professor Warren H. Wagner, Jr., of the University of Michigan, made a careful search for Ricciaceae in three of Michigan's southeastern counties, Wayne, Washtenaw, and Monroe. They (Mayfield et al. 1983) recorded three species of *Riccia* subgenus *Riccia*—*R. arvensis* Aust., *R. beyrichiana* Hampe, and *R. hirta* Aust.—and four of subgenus *Ricciella* — *R. fluitans, R. canaliculata* Hoffm., *R. sullivantii* Aust., and *R. cavernosa* Hoffm., in addition to *Ricciocarpos natans. Riccia sullivantii* (see Brodowicz 1990) and *R. cavernosa* have subsequently been documented as growing in other regions in Michigan.

The discovery of so many previously unrecognized species in Michigan is startling in view of the fact that they all came from the general vicinity of Ann Arbor. Although the University of Michigan at Ann Arbor has long been a center for bryological investigations, little collecting is usually attempted in the area during late autumn, particularly in the flat and intensively cultivated lands of the nearby Maumee Lake Plain where many of the *Riccia* collections were made. Because they searched wet arable soils at the cold end of the growing season when suitable habitats became temporarily available, Professor Wagner and his sharp-eyed co-workers were able to make many new discoveries. (They were also successful in finding a number of hornworts of considerable floristic interest, the records yet to be recorded in the literature.)

Riccias are short-lived plants. They often grow on wet soil in floodplains and commonly flourish in watersoaked, plowed fields that lie fallow over winter. In such bare-soil habitats they are soon crowded out by larger, more rapidly growing flowering plants. In arable lands, bare spots suited to pioneer Riccias are usually available from late fall until early spring. The

FIGURE 1. Two senescent thalli of *Riccia frostii* from the Sturgeon River station, Delta County, Michigan, (*Penskar s.n.*, 7 Aug 1988 (NYS)), with portion of a penny for scale, showing a proliferation of cell masses at lobe tips and, at right, the lacunose-pitted appearance sometimes seen in old plants. *Riccia cavernosa* is similarly lacunose, but the lobes are much broader, as seen in fig. 2. Photograph by Susan R. Crispin.

discovery of Riccias in southeastern Michigan was aided by unusually propitious climatic conditions in 1982, including spring flooding, followed by a wet summer and a particularly warm, wet fall.

A sizable *Riccia* flora should be expected in Michigan and elsewhere in the Great Lakes region, given the considerable diversity of habitats available for colonization. Schuster (1953) recorded 11 species from nearby Minnesota. The broad ranges of most of these species suggest occurrences in Michigan. Because of the abundance of species in Minnesota, some representation can be expected nearby in the northern regions of Michigan, though perhaps not in the diversity found in the more agricultural southeastern counties of the state.

On July 9, 1987, a small, very localized colony of *Riccia frostii* Aust. (Fig. 1) was discovered on a recently inundated, muddy bank of the Sturgeon River in the Upper Peninsula of Michigan near Nahma, Delta County. The colony was again observed in August when a collection of largely senescent individuals was made. Subsequent collections from the same locality were made in 1988 and 1989. This locality is, to our knowledge, the first one recorded for *R. frostii* in Michigan. Also found at the Delta County site (and growing with *R. frostii*) was a somewhat poor but identifi-

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FIGURE 2. Dried plant of *R. cavernosa*, (note lacunae) from the Sturgeon River station, *Penskar s.n.*, 7 Aug 1988 (NYS). [Scale divisions in mm.]

able specimen of *R. cavernosa* (Fig. 2), a distinctive species otherwise known from southeastern Lower Michigan. (American authors have generally given *Riccia cavernosa* the name *R. crystallina* L., though in error.) The occurrence of the latter species in Delta County represents a significant range extension within the state.

Riccia frostii is widely distributed in North America from British Columbia to New England and southward to California, Colorado, Kansas, Arkansas, Illinois, Indiana, and Virginia (Conrad & Redfearn 1979). Throughout its broad range this annual is most commonly found in riparian habitats, especially on silts at the margins of streams and rivers in the zone of periodic flooding (Clark & Frye 1928; McGregor 1955; Schuster 1953, 1957, 1966; Churchill & Redfearn 1977). In these habitats a natural disturbance regime of cyclic flooding prevents the establishment of vascular plants, which tend to shade out the pioneering Riccias (Schuster 1953). At the same time the continual deposition of alluvial silts and sands serves to perpetuate the open, mineral substratum necessary for the growth of Riccias.

Riccia frostii has the potential to become widespread and extremely abundant following large floods. McGregor (1952) reported a population explosion of this species following a major flood of the Kansas River, when several hundred square miles of silt deposited through the Kansas River valley became available for an estimated average of 1,699,202 rosettes of *R. frostii* per acre. The dissemination of *R. frostii* spores, however, may not be entirely due to water-dispersal. According to Schuster (1966, p. 177) "Szepesfalvy (1955) claims that spores of *Riccia frostii* are distributed on the feet and beaks of domestic geese (and also ducks)—and that the distribution of this species is concentrated in central Hungary along goose paths." Although Schuster thought that this claim needs further investigation, he noted that the probable role of shore and water birds in spore dispersal cannot be ignored.

The *Riccia frostii* station in Michigan occurs within a climatic region that has the longest and warmest growing season of any area of the Upper Peninsula (Albert et al. 1986). The region is warmer, in fact, than is much of the northern Lower Peninsula. The climatic conditions that prevail at the Sturgeon River result from the moderating effect of Lake Michigan. Associated with the relatively mild climate is a surprising number of "southern" species that tend to occupy floodplains throughout their ranges. The most notable of these is silver maple (*Acer saccharinum* L.), an overstory tree locally dominant for several miles along the river. Butternut (*Juglans cinerea* L.), also of a much more southern distribution (see Barnes & Wagner 1981), is an occasional overstory associate in the floodplain forest. Additional species of vascular plants present along the Sturgeon River floodplain, many of them at or near their northern distributional limit, include *Amphicarpaea bracteata* (L.) Fern., *Carex hirtifolia* Mackenzie, *Celastrus scandens* L., *Lindernia dubia* (L.) Pennell, *Parthenocissus inserta* (A. Kerner) Fritsch, *P. quinquefolia* (L.) Planchon, *Rudbeckia laciniata* L., *Smilax ecirrata* (Kunth) S. Watson, *S. illinoensis* Mangaly, *S. lasioneura* Hooker, *Toxicodendron radicans* (L.) Kuntze, *Viburnum lentago* L., and *Vitis riparia* Michaux, all to be expected in floodplain forests—though not uncommon in other habitats—in southern Michigan (Voss 1972, 1985; Barnes & Wagner 1981; Albert 1987).

Herbaceous vascular plants closely associated with *Riccia frostii* colonies were *Ludwigia palustris* (L.) Elliott, *Calamagrostis canadensis* (Michaux) Beauv., *Equisetum laevigatum* L., *Matteuccia struthiopteris* (L.) Todaro, *Penthorum sedoides* L., *Lindernia dubia, Juncus brevicaudatus* (Engelm.) Fern., *J. canadensis* La Harpe, *Leersia oryzoides* (L.) Sw., *Phalaris arundinacea* L., *Callitriche verna* L., *Mimulus ringens* L., and *Eleocharis elliptica* Kunth. A trace of the liverwort *Conocephalum conicum* (L.) Lindb. was found, as was a single plant of *Riccia cavernosa* with spores.

Riccia frostii (and other members of subgenus *Ricciella*) has a lacunose upper thallus, visible in fresh plants under low magnification in the older, central parts of rosettes. The compact, circular, dichotomously forked rosettes are distinctively gray-green in color and are characterized by relatively narrow and more or less parallel thallus segments that tend to be

crowded to slightly overlapping (Fig. 1). Male plants are reported to be smaller than female ones (Jovet-Ast 1986). Older portions of mature thalli are brownish and somewhat spongy, but are by no means as lacunose as plants of *R. cavernosa* (Fig. 2). In *R. frostii* the capsules are included in the thallus but not in tumor-like ventral bulges (such as those of *R. sullivantii*). The spores are dispersed when upper tissue disintegrates. Spores are usually produced abundantly, appearing as coarse, black masses extruded on the dorsal surface of the thallus and sometimes covering the entire surface (Schuster 1953). The spores are relatively small, ranging from 46–58 μm (Fig. 3) and have irregular subparallel ridges that may anastomose slightly toward the middle of the distal face but do not form a distinctly reticulate pattern. In *R. cavernosa,* with which *R. frostii* sometimes grows, the spores are larger and clearly reticulate (Fig. 4).

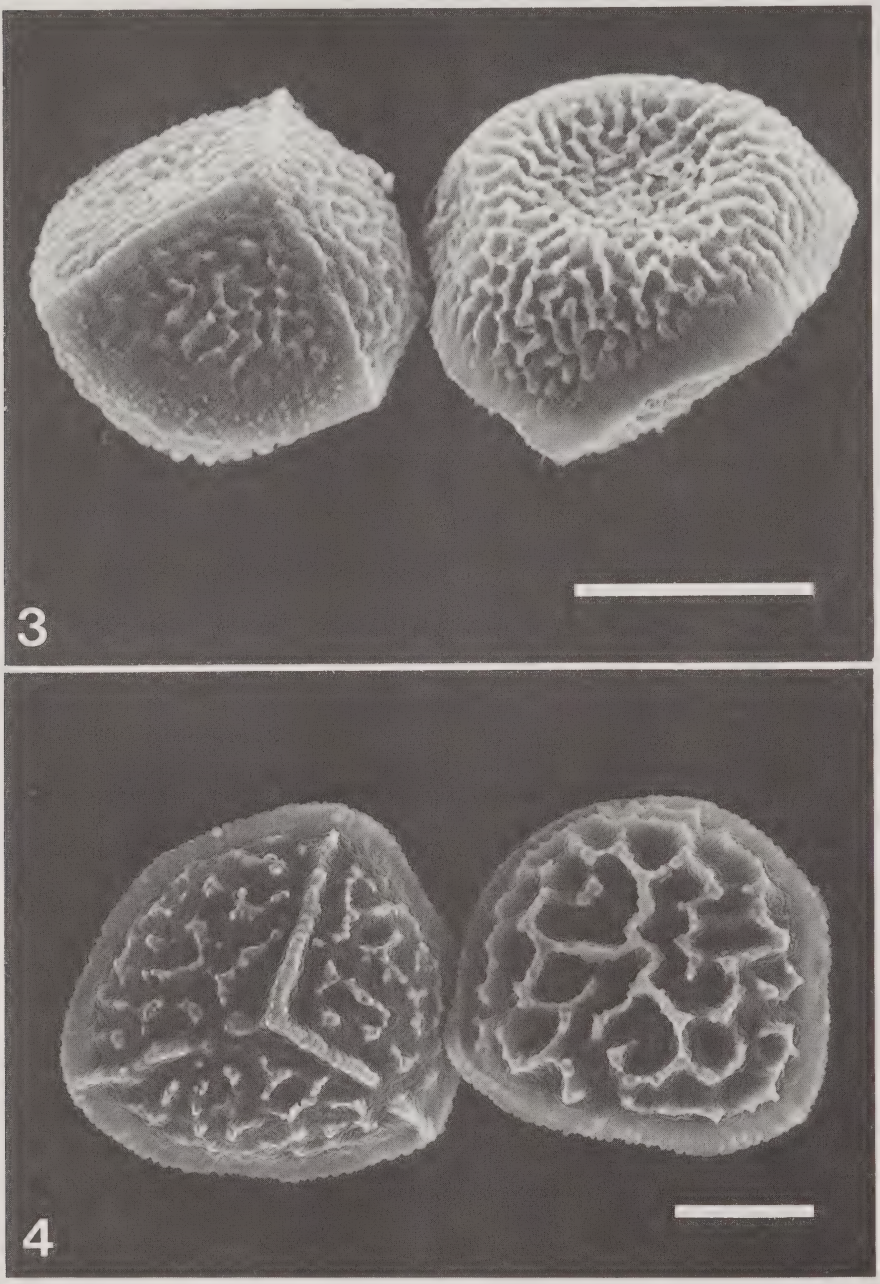
The plants of *Riccia frostii* from Delta County formed rosettes 12–25 mm in diameter. They appear to have grown in partial shade, as the lobe margins were not or only slightly reddish-colored. The lobes of the thallus just behind the final dichotomies measured about 2 mm wide, and the median furrow (sulcus) was shallow and inconspicuous. The short, new growth, upturned at the tips of the lobes, bore very short hairs, suggestive of cilia, but were actually much less developed than are the cilia of other species. Black spore masses of a spherical form were visible in older, more central sections of the thallus, some of them erupted at the surface. In younger parts of the thalli mature sporophytes topped by the remains of the neck of the archegonium and containing green spores were visible through the upper tissue. In these, the spores were immature and in tetrads.

The pattern of sporophyte maturation observed in the field in 1987 and in specimens kept in culture confirm the annual nature of *Riccia frostii*. The Sturgeon River plants appear to have originated from spores germinated in the spring after flood waters receded, and continued development during the relative droughty summer owing to the moistness of the muddy riverbank.

Specimens of *Riccia frostii* collected in 1989 were obtained within ca. 0.5 mi. of the colony discovered in 1987 and observed again in 1988. Since the habitat is relatively common for several miles along the lower portion of the Sturgeon River, *R. frostii* will undoubtedly prove to be much more widespread in the watershed. Searches of other riparian habitats in the Upper Peninsula are very likely to result in additional localities for *R. frostii*, and quite possibly new records of other species of *Riccia*.

The following specimens summarize all known Michigan collections of *Riccia frostii. Riccia cavernosa* was seen in only one collection, as noted below. The specimens are deposited in the Herbarium of the University of Michigan (MICH) unless otherwise noted.

DELTA CO.: On muddy shore of oxbow of Lower Sturgeon River, just E of Co. Rd 497, ca. 2 mi S of US 2, associated with *Ludwigia palustris, Calamagrostis canadensis,* and *Conocephalum conicum,* N 1/2 of Sec. 17, T40N, R19W, *M. R. Penskar & D. Henson s.n.*, 9 Jul 1987; edge of bank of Lower Sturgeon River, on sand with *Riccia cavernosa, Juncus brevicaudatus, Equisetum laevigatum, Lindernia dubia, Penthorum*



FIGURES 3–4. 3. Spores of *Riccia frostii*, proximal face (left), distal face (right) (*Penskar s.n.*, 7 Aug 1988 (NYS)). 4. Spores of *R. cavernosa*, proximal face (left), distal face (right) (*Penskar s.n.*, 7 Aug 1988 (NYS)). [Scale bars = 25 μm.]

sedoides, Callitriche verna, and *Mimulus ringens*, Sec. 17, T40N, R19W, *M. R. Penskar s.n.*, 7 Aug 1988 (NYS); occasional on moist sandy bank of Sturgeon River, ca. 1 mi N of Nahma, at bridge on Co. Rd 497, occurring with *Juncus canadensis, Lindernia dubia,* and *Ludwigia palustris*, SE 1/4 of Sec. 17, T40N, R19W, *M. R. Penskar s.n.*, 15 Aug 1989.

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Don Henson is gratefully acknowledged for assisting in the collection of specimens and the identification of vascular plants. Sue Crispin kindly provided a close-up photo of *Riccia frostii*, and Dr. Raymond E. Stotler and an anonymous reviewer provided helpful comments. *Riccia frostii* was discovered during MNFI surveys of the Sturgeon River candidate Research Natural Area, a project funded by the Hiawatha National Forest, USDA-U.S. Forest Service.

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REVIEW

ISOZYMES IN PLANT BIOLOGY. Edited by Douglas E. Soltis and Pamela S. Soltis. Dioscorides Press. 9999 S.W. Wilshire, Portland, OR 97225. 1989. 268 pp. $35.95 plus $3.00 shipping.

The number of isozyme studies of plants has increased significantly during the last decade. *Isozymes in Plant Biology* reviews applications of isozyme data (especially allozymes, the allelic variants at isozyme loci) to problems in population biology, evolutionary and systematic studies, and plant breeding. Each of the twelve contributed chapters is followed by an extensive bibliography. The book is to some extent an update of *Isozymes in Plant Genetics and Breeding, Part A* (S. D. Tanksley and T. J. Orton. 1983. Elsevier Press, Amsterdam), and includes many studies done since the earlier book. The book does not treat individual species in depth as was done in Part B of the Tanksley and Orton volumes.

The first two chapters deal with methods and interpretation of isozymes, namely visualization and interpretation of plant isozymes (J. F. Wendel and N. F. Weeden), and the genetics of plant isozymes (N. F. Weeden and J. F. Wendel). These chapters are an excellent source on how to carry out an isozyme study, and the latter chapter provides a particularly valuable discussion on the genetics, localization, and subunit organization of different enzymes; information needed for interpreting results on gels. Additional details on how starch gel studies are performed in different labs can be found in a paper by S. Kephart (Amer. J. Bot. 77: 693–712.1990) Several chapters deal with aspects of population biology, including plant mating systems (A. H. D. Brown et al.), genetic structure of plant populations (J. L. Hamrick), genetic structure of colonizing plants (S. C. H. Barrett and J. S. Shore), and geographic and physiological variation in allozymes (J. B. Mitton). The results of studies in this area have brought some major changes in our view of natural populations. Other chapters focus on systematics and evolutionary applications, including enzyme electrophoresis and plant systematics (D. J. Crawford), systematic and evolutionary implications in bryophytes (R. Wyatt et al.), and polyploidy, breeding systems, and genetic differentiation in homosporous ferns (D. E. Soltis and P. S. Soltis). The isozyme studies of ferns and bryophytes have also led to fundamental re-evaluation of some old ideas. Chapters on crop plants discuss origins and evolution of certain crops and relationships with wild relatives (J. Doebley), isozyme analysis of tree fruits (A. M. Torres), and use of isozymes as genetic markers for quantitative traits (C. W. Stuber).

Recent years have seen an explosion in the number of DNA studies that address many of the questions that are dealt with in this book, and DNA is likely to supplant isozymes for many purposes. However, for reasons of speed and cost, isozymes will likely remain useful and preferable for many studies, and can also provide complementary information. A chapter contrasting the relative advantages of DNA and isozyme studies would have been a welcome addition, although the rapid changes currently experienced in DNA technology continue to alter the picture. This book will serve as a reference to how isozymes have proven useful, and may thus assist decisions on which method is most appropriate for a particular study. The book is well written and edited, and is a recommended addition to the library of anyone with interests in the areas treated.

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RUBUS PARVIFOLIUS (ROSACEAE), NATURALIZED IN ILLINOIS AND IOWA[1]

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INTRODUCTION

While travelling to and from work, the senior author noted a vigorous bramble covering about a 20-meter section of hillside along a road bordering the North Central Regional Plant Introduction Station farm, southwest of Ames, Iowa. Upon closer examination, the bramble seemed to be significantly different from those species described in floras of surrounding states (Great Plains Flora Association 1986, Mohlenbrock 1986, Steyermark 1963). This plant was identified as *Rubus parvifolius* L. (= *R. triphyllus* Thunb., non *R. parvifolius* Walter), the trailing raspberry, using Rehder's (1940) key.

The senior author initially suspected that this species had merely been persisting near the Plant Introduction Station after cultivation, but then he noticed the same bramble in other locations around Ames, where the plant was naturally reproducing and clearly not under cultivation. This species' vigorous growth (at one site it covers over 1000 square meters of thin woodland understory) and its production of fruits attractive to birds suggest that the plant is now well established and should be considered a member of the local flora.

The discovery of *R. parvifolius* in Iowa, along with its absence from nearly all North American floristic manuals, prompted this work.

HISTORICAL ACCOUNT

Previous reports of *R. parvifolius* escaping from cultivation in North America are limited to a few records from the Boston, Massachusetts area. Rich (1908) reported the phenomenon first, finding *R. parvifolius* on "Back Bay lands" in 1907 (*W. P. Rich s.n.*, 26 Jun 1907, A[2]) and taking it to Alfred

[1]Journal Paper No. J-14243 of the Iowa Agriculture and Home Economics Experiment Station, Ames, Iowa. Project No. 1018.

[2]The abbreviations for herbarium names follow Holmgren et al. (1990).

Rehder of the Arnold Arboretum for identification. In a later report of the same collection, Knowlton and Deane (1918) provided a clue to the source of the plant: "a native of Japan, escaped from Fenway." Fernald (1950) mentioned the synonymous *R. triphyllus* in his *Rubus* treatment, noting that it "has appeared in vacant lots in Boston, Mass.," but did not include it in his key.

Specimens at BH indicate that *R. parvifolius* has been cultivated at the Arnold Arboretum since at least 1915 (*L.V. Schmidt s.n.*, 3 Nov 1915, BH). In at least one instance, this bramble escaped cultivation there, for E.J. Palmer commented that the plant was "escaped and well established" on a slope in 1948 (*Palmer 48417*, BH).

Commercial interest in this species in the U.S. began in 1929 with the collection of seed in Japan by P.H. Dorsett and W.J. Morse of the Division of Plant Exploration and Introduction of the U.S. Department of Agriculture (USDA) and with subsequent horticultural studies by Williams and Darrow (1940) in Maryland and North Carolina. These researchers noted that the species was both resistant to a number of common diseases infecting the related bramble *Rubus idaeus* L., red raspberry, and that it had a large berry of "fair quality." Attempts were then made to use this species as a means of improving the disease resistance of cultivated red raspberries in breeding programs (Darrow 1937) and, more directly, as a parent in new hybrid fruit cultivars (Williams & Darrow 1940). *Rubus parvifolius* has since been used sporadically to breed red raspberries for warm climates (Jennings 1988).

In 1938, the Soil Conservation Service (SCS) of the USDA established a cooperative research program with a number of state agricultural experiment stations, including Iowa's, to improve the management of agricultural production on sloping lands (Bennett 1938). In the late 1930s, a Hill Culture Research Station was established southwest of Ames, Iowa by the SCS, in cooperation with the Iowa Agriculture and Home Economics Experiment Station. It was used until 1947 by the SCS to study plants that control soil erosion and to develop new cropping systems. The site was then transferred to the newly-formed North Central Regional Plant Introduction Station.

To date, there is no direct evidence that the Hill Culture Research Station in Iowa cultivated *R. parvifolius*. However, the 1946 Annual Reports of the Department of Agriculture (Bennett 1946) noted that research was under way by the Hillculture Research Division on the cultivation of cane fruits, which probably included *Rubus*, on eroded lands in Iowa. Williams and Darrow (1940) noted that *R. parvifolius* has a growth habit making it especially well-suited to covering eroded banks, and it is plausible that the Hill Culture Research Station was working with this species. A search of all accession records of the North Central Regional Plant Introduction Station provided no evidence that *R. parvifolius* had ever been cultivated at the Station, so its presence in the area most likely dates to before 1947.

Another potential source for the introduction of *R. parvifolius* to Ames was the *Rubus* breeding program of T.J. Maney at Iowa State College (now University). Maney (1945) reported growing hybrids between *R. parvifolius*

and red raspberry, but it is not known whether he ever grew *R. parvifolius* in the field.

If the Hill Culture Research Station in Iowa was cultivating *R. parvifolius*, it is also possible that other SCS programs were working with this plant in the 1940s. One region that received a great deal of attention by the SCS at that time was an area of highly erodable, sandy soils along the Illinois River (Keith Van De Velde, pers. comm.). Mason County, Illinois, which includes large expanses of such soils, is the only other midwestern county where *R. parvifolius* has been collected away from cultivation.

KNOWN COLLECTIONS IN ILLINOIS AND IOWA AND CURRENT STATUS

Illinois

Naturalized populations of *R. parvifolius* were first collected in the midwestern U.S. by R.T. Rexroat on 31 May 1959, in Mason County, Illinois, southwest of the village of Bath along the edge of a woods (*Rexroat 5755*, BH and *5756*, ISM). Later in 1959, he located a second population growing on sandy soil on the edge of a woods west of the village of Saidora, also in Mason County. He made many collections at this site between 1959 and 1969 (representatives include *Rexroat 9375*, BH and *5891*, ISM). In 1961,a third population was discovered northeast of Saidora, where collections were made between 1961 and 1969 (representatives include *Rexroat 7503* and *10750*, ISM).

In June, 1990, the senior author spent two days in Mason County in an unsuccessful attempt to relocate these populations. Personnel from the Mason County Soil and Water Conservation District, the SCS, and the Illinois Natural History Survey are continuing the search.

Rexroat's widow donated his field collection notes to the herbarium at Western Illinois University (MWI) (R.D. Henry, pers. comm.). The senior author contacted R.D. Henry, curator of MWI, after the unsuccessful search, to see if Rexroat's original notes might be helpful in pinpointing the collection sites.

Henry was acquainted with Rexroat and accompanied him into the field before his death in 1979. (An obituary of Rexroat describes many aspects of this amateur naturalist's interesting life [Henry 1979]). Henry has searched Rexroat's field notes and interviewed some of his field companions at our request, but has not yet uncovered useful information to pinpoint *R. parvifolius* collection sites.

Henry was aware, however, that Rexroat had discovered an unusual bramble. Rexroat transplanted *R. parvifolius* from Mason County to his home in Virginia, Illinois, and he gave Henry a cutting from the planting at his home along with an explanation of this plant's rarity. Although we have not been able to relocate this species in Mason County, plants originating from one of Rexroat's populations are thriving on the campus of Western Illinois University in Macomb (*Henry & Scott 6036*, MWI).

Iowa

On 1 June 1988, *R. parvifolius* was collected from populations growing in Story County, Iowa. Three populations in the vicinity of Ames were sampled during the summer of 1988.

STORY CO.: An east-facing bank along State Avenue S of Mortensen Road, NE1/4 of SE1/4 of SE1/4 of Sec. 8, T83N, R24W, *Widrlechner 169* (ISC) and *181* (BH, ISC, MICH); along the S edge of the Chicago & Northwestern Railway right-of-way, N of 4109 and 4115 Toronto Street, W edge of SE1/4 of SW1/4 of Sec. 32, T84N, R24W, *Widrlechner 170*, (ISC) and *182* (ISC, MICH); and an open, mixed deciduous forest on a north-facing slope in Reactor Woods, SE1/4 of NE1/4 of Sec. 32, T84N, R24W, *Widrlechner 171* (ISC, MICH) and *183* (BH, ISC).

A fourth population was found in 1989 in a disturbed woodland on the edge of the Iowa State University campus.

STORY CO.: 25 meters E of the intersection of Pammel Drive and Hyland Avenue, SE1/4 of NW1/4 of Sec. 4, T83N, R24W, *Widrlechner 273* (ISC).

Additional collections from Story County are deposited at CM, MIL, and MO.

DIAGNOSTIC FEATURES AND KEY

Features of the flowers and fruits clearly place *R. parvifolius* (Fig. 1) in the subgenus *Idaeobatus*. In leaf, flower, and fruit characteristics, it is so unlike any of the native, trailing members of subgenus *Eubatus* that this treatment will compare *R. parvifolius* only to other species of the subgenus *Idaeobatus* found native or naturalized in the midwestern U.S. and to *R. odoratus* L.

Table 1 lists important morphological features that can be used to distinguish *R. parvifolius* from the native raspberries, *R. occidentalis* L. and *R. strigosus* Michaux, and from the introduced species found in the region, *R. idaeus* and *R. phoenicolasius* Maxim. Data for this table were collected from living material and from herbarium collections at ISC.

In any season, the most obvious characteristic that can be used to distinguish *R. parvifolius* is its habit. It grows in a mounding tangle unlike any of the other *Idaeobati*. The rose-pink petals and glossy, bright red fruits are readily obvious characteristics at certain times. In Iowa, flowering occurs from late May to early June, and fruits ripen from late June into July.

There is another species of *Rubus* with rose-pink petals and red fruits that is native to the midwestern U.S. It is *R. odoratus*, a member of the subgenus *Anaplobatus*. This bramble has upright, unarmed canes, simple leaves, and large, showy flowers and in these respects is quite different from *R. parvifolius*.

The following key may be used to distinguish *R. parvifolius* from *R. odoratus* and from species of subgenus *Idaeobatus* described in Table 1.

FIGURE 1. *Rubus parvifolius* from Plate 496 in Ker-Gawler (1820).

Table 1. Comparison of key characteristics of *Rubus parvifolius* and other members of Subgenus *Idaeobatus*.

Characteristic	*R. parvifolius*	*R. idaeus*	*R. occidentalis*	*R. phoenicolasius*	*R. strigosus*
1. Habit	decumbent, tip-rooting and occasionally rooting at other nodes	erect, not tip-rooting	arching, tip-rooting	long-arching, tip-rooting	erect to arching, not tip-rooting
2. Primocane color	green to purple-green, reddish-brown in winter	light green, tawny or light purple	green to purple, purple in winter, often glaucous	dark purple	light green, tawny or light purple
3. Primocane armature	slender prickles	none, or with slender to broad-based prickles	broad-based prickles	densely covered with purple stipitate glands and occasional prickles	stiff bristles and stipitate glands
4. Leaf persistence	may persist until mid-winter	deciduous	deciduous	deciduous	deciduous
5. Primocane leaf type	ternate or quinate, pinnate	ternate or quinate, pinnate	ternate or quinate, digitate	ternate	ternate or quinate, pinnate
6. Primocane central leaflet shape	obovate to broadly subrhombic, obtuse tip, cuneate base	ovate to elliptic, sometimes three-lobed, acuminate tip, cordate base	ovate to elliptic, acuminate tip, cordate to truncate base	broadly ovate, abruptly short-acuminate tip, cordate to rounded base	ovate to elliptic, sometimes three-lobed, acuminate tip, cordate base
7. Pedicel armature	slender prickles	slender prickles	slender to broad-based prickles	densely covered with purple stipitate glands	stipitate glands
8. Petal color and shape	rose-pink, spatulate	white to green-white, spatulate to obovate	white, narrowly obovate	white, narrowly obovate	white to green-white, spatulate to obovate
9. Mature fruit color	bright, glossy red	purple-red, rarely yellow	purple-black, rarely amber	cherry red	purple-red

FIELD KEY TO *RUBUS ODORATUS* AND SPECIES OF *RUBUS* SUBG. *IDAEOBATUS* NATIVE OR INTRODUCED TO THE MIDWESTERN UNITED STATES

1. Leaves simple; canes unarmed with exfoliating bark .... *R. odoratus*
1. Leaves compound; canes usually armed (except in some forms of *R. idaeus*) without exfoliating bark
   2. Canes erect or arching, not rooting at tips
      3. Primocanes with stiff bristles and stipitate glands .. *R. strigosus*
      3. Primocanes lacking stipitate glands ..... *R. idaeus*
   2. Canes arching to decumbent, rooting at tips
      4. Primocanes densely covered with purple stipitate glands . . . *R. phoenicolasius*
      4. Primocanes lacking stipitate glands
         5. Primocanes purple in winter, often glaucous; primocane central leaflet ovate to elliptic, with an acuminate tip and a cordate to truncate base ..... *R. occidentalis*
         5. Primocane reddish-brown in winter, not glaucous; primocane central leaflet obovate to broadly subrhombic with an obtuse tip and a cuneate base ..... *R. parvifolius*

SUMMARY

Rubus parvifolius is a previously unremarked member of the flora of the midwestern U.S. It may have been introduced to the region by the SCS. It is possible that it occurs more widely in the region and might be expected to occur in areas of high erosion or near old SCS research sites. This report presents a table of characteristics and a key that can be used to distinguish this species from related brambles in the field.

The authors would be interested to learn of other occurences of this species in the midwestern flora.

ACKNOWLEDGMENTS

Many individuals have assisted us in the search for information about *Rubus parvifolius.* We are especially grateful for help given by Douglas Helms, Bob Henry, Kim Hummer, Deborah Lewis, and the staff of the SCS office in Mason County, Illinois. We also wish to thank the curators of A, BH, and ISM for providing loans of *R. parvifolius*; the curators of BH, BUT, COLO, IND, MO, NA, WIS, and WTU for hospitality during visits; the curators of F, GH, ILLS, MO, NCSC, NY, SMU, UBC, UC, and US for searching their collections; and to Neil Harriman, Deborah Lewis, Gail Nonnecke, Richard Pohl, Ken Robertson, and an anonymous reviewer for their useful critiques of this report.

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V REVIEW

BOTANY FOR GARDENERS. By Brian Capon. Timber Press, Inc., 9999 S.W. Wilshire, Portland, OR 97225.1990. 220 pp. $29.95.

The title of this attractively produced, compact volume implies that its content differs from that of an introductory botany textbook, which is the alternative source for a gardener interested in learning basic botanical science. One would expect such a book to relate sound gardening practice directly to its underlying botanical theory, i.e. botany should provide the "why" for the "how" of gardening. However, this is not the case. For example, seed germination requirements are discussed in some detail but not in the context of methods a skilled gardener uses to get seed of uncommon plants to germinate. The discussion of mineral nutrition does not relate to practical matters of choosing, quantifying, and applying fertilizers; there is no mention of the biology of composting. Nor does the section on plant classification deal more specifically with problems the gardener may face in identifying plants in his collection. Rather, *Botany for Gardeners* is essentially an introductory botany text which crams the subject matter ordinarily requiring 300 to 400 pages into 220 pages. This is not to say that the book is poorly written or the content uninteresting. The challenge for the reader is to assimilate the mass of facts and concepts densely packed on each page. One would hope that the interested gardener will be sufficiently motivated to expend the effort that will be required.

The organization of subject matter in this presentation does not seem entirely logical. The topic of adaptation would be more appropriately discussed following the sections on function, flowers and fruits, and reproduction. Genetics, which today is central to all biology, is deferred until the last

chapter, and given less than minimal coverage. The superficial treatment of many important processes and concepts, (e.g. respiration, meiosis, evolution) is not likely to give the serious reader the understanding of botany that he seeks.

The photographs are excellent and the other illustrations well done. More drawings and diagrams would have enhanced the understanding of some of the concepts discussed in the text. The inclusion of Latin and Greek meanings of botanical terms is useful in making the lay reader aware that scientific terminology does have a rational basis. It would seem desirable that a book intended for a lay readership give, in addition to factual information, insight into the nature of science and how a gardener might contribute to scientific knowledge. This is not apparent in the author's approach; his style is more directed toward extolling the wonderment of nature, often with a teleological flavor and using such phrases as the "dance of the chromosomes" and "Not all flowers are so cunning."

The gardener seriously interested in acquiring a knowledge of basic botany would do well to compare *Botany for Gardeners* with one or two standard introductory botany texts before selecting the source of his botanical information.

—Erich Steiner
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Erratum

The name of the photographer who supplied the cover photographs for Vol. 27, No. 4 (October 1988) and Vol. 29, No. 3 (May 1990) was misspelled in the credit line for these covers. The correct name is Marny Payne.

The October issue (Vol. 29, no. 4) was mailed March 28, 1991

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Photographed by Richard W. Pippen

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THE MICHIGAN BOTANIST

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THE GENUS FRULLANIA (HEPATICAE) IN MICHIGAN

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INTRODUCTION

Representatives of the leafy liverwort genus *Frullania* (Jungermanniales: Jubulaceae) grow on the bark of trees throughout Michigan and infrequently occur on rocks. The genus is primarily tropical and, according to Engler's *Syllabus der Pflanzenfamilien* (Melchior and Werdermann 1954), 700 species have been described. The *Index Hepaticarum* of Bonner (1965) lists 1037 specific epithets for *Frullania*. It is likely, however, that a considerable number of these are synonyms.

Evans' (1897) revision of *Frullania* in North America included 22 species for North America as did Frye & Clark's (1937–1947) treatment. Steere's *Liverworts of Southern Michigan* (1940) included only two species (*F. eboracensis* and *F. asagrayana*) and indicated that two others (*F. brittoniae* and *F. plana*) have been collected only once in Michigan. *Frullania brittoniae* has since been found elsewhere in the state but the status of *F. plana* remains problematic. Crum (1991) reports that the single collection has not been found. He believes its mention by Steere (1940) was a "slip of the pen for *F. inflata*." Schuster's *Boreal Hepaticae* (1953) included 10 species for the northern Great Lakes region, particularly Minnesota. Recently, Hong (1989) included 11 species for North America west of the hundredth meridian, a line running from Manitoba to central Texas.

MATERIALS AND METHODS

Frullania species were collected and field records were accumulated from various parts of Michigan between 1985 and 1990. These were supplemented with material borrowed from the following Michigan herbaria: MCTC, MICH, MSC, NM, UMBS, and WMU (abbreviations from *Index Herbariorum* (Holmgren et al. 1990)). 488 specimens were obtained and examined. Identifications were checked against non-Michigan collections housed at MICH. Hoyer's solution slides were prepared to facilitate comparisons and to reveal details such as intermediate cell wall thickenings and perianth tuberculation. Herbarium labels and packets were annotated and distribution maps prepared. Environmental data were tabulated for each species from field notes and herbarium label records. These data will make it possible to compare the habitats of Michigan Frullanias with their habitats in other parts of their distribution ranges.

KEY TO MICHIGAN SPECIES OF *FRULLANIA*

1. Autoicous (antheridial and archegonial branches on the same plant) . . . 2
   2. Dorsal lobe with a row of specialized cells (ocelli) . . . 2. *F. selwyniana*
   2. Dorsal lobe lacking ocelli . . . 3
      3. Inflated lobules large, more than half the area of the dorsal lobes . . . 6. *F. oakesiana*
      3. Inflated lobules small, less than half the area of the dorsal lobes . . . 4. *F. inflata*
1. Dioicous (antheridial and archegonial branches on different plants) . . . 4
   4. Dorsal lobes with a row of specialized cells (ocelli) . . . 1. *F. asagrayana*
   4. Dorsal lobes lacking ocelli . . . 5
      5. Lobules explanate; underleaves more than twice the width of the stem . . . 5. *F. riparia*
      5. Lobules inflated and helmet-shaped; underleaves less than twice the width of the stem . . . 6
         6. Plants with ascending branches bearing only underleaves . . . 3. *F. bolanderi*
         6. Plants lacking ascending branches; lateral leaves present . . 7
            7. Plants large (usually 1.0–1.2 mm wide); caducous-leaved branches and/or gemmae usually not present; lobules compressed at the mouth; underleaves usually wider than long with dentate or crenate-dentate margins; cells of middle of the dorsal lobe with few or no intermediate thickenings . . . 8. *F. brittoniae*
            7. Plants small (usually 0.7–0.9 mm wide); caducous-leaved branches and/or gemmae frequently present; lobules usually not compressed at the mouth; underleaves usually longer than broad, entire or with a single tooth on one or both lobes; cells of middle of the dorsal lobe with frequent intermediate thickenings . . . 7. *F. eboracensis*

KEY TO STERILE COLLECTIONS OF MICHIGAN SPECIES OF *FRULLANIA*

1. Dorsal lobe with a row of specialized cells (ocelli); plants red-brown . . . 2
   2. Plants large (1.0–1.5 mm wide) . . . 1. *F. asagrayana*
   2. Plants small (0.5–0.8 mm wide) . . . 2. *F. selwyniana*
1. Dorsal lobe lacking ocelli; plants red-brown, green, or blackish-green . . . 3
   3. Plants blackish with ascending branches bearing only underleaves

. . . 3. *F. bolanderi*

3. Plants not black; without ascending branches; lateral leaves present . . . 4
4. Lobules explanate; underleaves more than twice the width of the stem ..... 5. *F. riparia*
4. Lobules inflated and helmet-shaped; underleaves less than twice the width of the stem 5
5. Lobules large, more than half the area of the dorsal lobe . . . 6. *F. oakesiana*
5. Lobules small, less than half the area of the dorsal lobe .. 6
6. Dorsal lobe straight or rounded at base .... 4. *F. inflata*
6. Dorsal lobe cordate at base 7
7. Plants larger (usually 1.0–1.2 mm wide); caducous-leaved branches and/or gemmae usually not present; lobules compressed at the mouth; under-leaves usually wider than long with dentate or crenate-dentate margins; cells of middle of dorsal lobe with few or no intermediate thickenings ..... 8. *F. brittoniae*
7. Plants smaller (usually 0.7–0.9 mm wide); caducous-leaved branches and/or gemmae frequently present; lobules usually not compressed at the mouth; underleaves usually longer than broad, entire or with a single tooth on one or both lobes; cells of middle of dorsal lobe usually with frequent intermediate thickenings ..... 7. *F. eboracensis*

1. *Frullania asagrayana* Mont. Map 1

This dioicous species is frequent and locally abundant on trunks and bases of trees throughout the Upper Peninsula of Michigan and in the Lower Peninsula above the "Tension Zone," a belt running approximately from lower Saginaw Bay westward across the state to Muskegon.

It has also been treated as *Frullania tamarisci* (L.) Dum. subsp. *asagrayana* (Mont.) Hatt. As a result of field and herbarium studies, as well as observations on growth in axenic culture and comparison of isozymes, phenolics, and terpenoids, Crandall-Stotler et al. (1987) recommended that the species should be maintained as separate. That recommendation is followed here.

Frullania asagrayana is distinctive throughout its range in Michigan. The plants are shiny red-brown, large (0.8—1.3 mm wide and 1—4 cm long), loosely attached to the substrate, and characterized by narrow lobules, generally twice as long as broad and set at an angle to the stem, and a median vein-like row of pigmented cells (ocelli) in the dorsal lobes. The only Michigan species with which it might be confused is *F. selwyniana,* which is smaller, more regularly pinnate, and autoicous. The 31 collections of *F. asagrayana* examined indicate that it grows most frequently on *Thuja* (13)

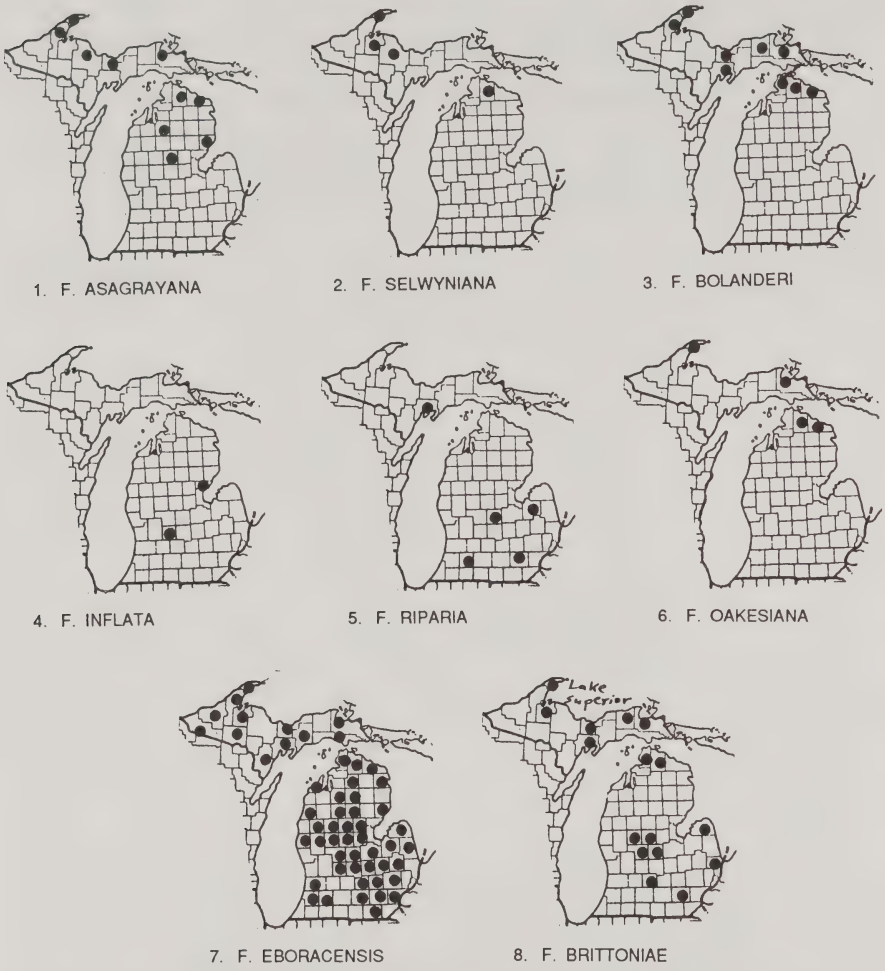


FIGURE 1. Known distribution by county of eight species of *Frullania* in Michigan.

and less frequently on *Abies* (3), *Betula* (3), unspecified tree trunks (3), rock (3), *Acer* (2), *Tsuga* (2), and *Populus* (1).

Representative specimens examined. ALGER CO.: near Munising, 27 Aug 1937, *G.H. Conklin s.n.* (MICH). CHEBOYGAN CO.: Carp Creek, *Ehrle 7569* (WMU). CHIPPEWA CO.: Vermillion, *Povah 180* (MICH). CLARE CO.: no locality, 12 Dec 1937, *I. Schnooberger s.n.* (MICH). HOUGHTON CO.: Jacobsville, Sep 1935, *W.C. Steere s.n.* (MICH). IOSCO CO.: Ausable River, *Engel 3690* (MSC). KALKASKA CO.: Rapid River, *Schuster 38955* (MICH). KEWEENAW CO.: Ryan Island, *Povah 335* (MICH). MARQUETTE CO.: 28 Aug 1936, *W.C. Steere s.n.* (MICH). PRESQUE ISLE CO.: Presque Isle, *Anderson 178* (WMU).

2. *Frullania selwyniana* Pers. Map 2

This autoicous species is known only from the western counties of the Upper Peninsula and from Cheboygan County in the Lower Peninsula.

Frullania selwyniana may be recognized by its autoicous mode of reproduction, its red-brown color, and the row of specialized cells (ocelli) in its dorsal lobes. It shares this latter character with *F. asagrayana*, from which it differs in its smaller size and autoicous reproduction.

Examination of the 10 Michigan collections available indicates that it grows mainly, perhaps exclusively, on *Thuja* (6). Three additional collections are from unspecified trees in cedar swamps. One collection lacked sufficient label data to determine substrate.

Representative specimens examined. BARAGA CO.: E of L'Anse, Sep 1938, *W.C. Steere s.n.* (MICH). CHEBOYGAN CO.: Burt Lake, 22 Jul 1940, *W.C. Steere s.n.* (MICH); Iron Bridge, 13 Jul 1979, *B.C. Tan s.n.* (MICH). KEWEENAW CO.: Isle Royale, *Wetmore 2535* (MSC); no date or locality, *C.M. Wetmore s.n.* (MICH); no locality, *Miller 7111* (MICH). MARQUETTE CO.: Lake Huron Mts., Jun 1937, *G.E. Nichols s.n.* (MICH); Shores of Mt. Lake, Jun 1937, *G.E. Nichols s.n.* (MICH).

3. *Frullania bolanderi* Aust. Map 3

This dioicous species is common and locally abundant on tree trunks and bases in the Upper Peninsula and the three northernmost counties of the Lower Peninsula.

Frullania bolanderi is distinctive throughout its range in Michigan. The plants are blackish and characterized by ascending branches bearing squarrose underleaves but no regular stem leaves. It is unlikely to be confused with any other Michigan *Frullania*. The 85 collections examined indicate that it grows most frequently on *Acer* (29), *Betula* (10), and *Fagus* (10) and less frequently on *Quercus* (2), *Ostrya* (1), *Populus* (3), *Ulmus* (3), rock (3), and decayed wood (1). The remaining collections (23) lacked sufficient label data to determine substrate.

Representative specimens examined. ALGER CO.: Munising, *Ehrle 7530* (WMU). CHARLEVOIX CO.: Chandler, 31 Aug 1969, *H. Crum s.n.* (MICH). CHEBOYGAN CO.: Lake Sixteen, *Miller 4037* (MSC). CHIPPEWA CO.: Tahquamenon Falls, *Ehrle 7536* (WMU). DELTA CO.: Summer Island, *Miller 4723* (MICH). EMMET CO.: Lake Shore Drive, *Ehrle 7566* (WMU). GOGEBIC CO.: Black River, *Steere 3429* (UMBS). HOUGHTON CO.: Coles Creek Road, *Glime 9689* (MCTC). KEWEENAW CO.: Jacob's Creek, *Glime 3057* (MCTC). LUCE CO.: Upper Tahquamenon Falls, 2 Aug 1966, *H. Crum s.n.* (UMBS). MACKINAC CO.: Gros Cap, *Miller 3586* (MICH). MARQUETTE CO.: Sugar Loaf Mt., 29 Aug 1936, *W.C. Steere s.n.* (MICH). ONTONOGON CO.: Porcupine Mts., 20 Aug 1935, *G.E. Nichols s.n.* (MICH). PRESQUE ISLE CO.: Rogers Twp., *Miller 3429* (UMBS).

4. *Frullania inflata* Gott. Map 4

This autoicous species is known from only two locations in Michigan, one from a tree trunk in Ionia County, the other from a steep sandy bank near the Ausable River in Iosco County.

Frullania inflata may be readily recognized by its autoicous means of reproduction, helmet-shaped lobules, and near absence of intermediate thickenings of the cell walls of the dorsal lobes of stem leaves and their abundance in the ventral lobules. When sterile, the species may be recognized by its fairly large size (1 mm or more wide), occasional presence of explanate lobules, and fairly large underleaves. Although *F. inflata* shares the latter two characteristics with *F. riparia*, that species is smaller (less than 1 mm wide) in all Michigan material examined. *Frullania inflata* may be more common than reported here due to its being overlooked in the sterile condition as merely a large form of *F. eboracensis*, which is usually limited to 0.5—0.8 mm wide. A careful examination of 323 Michigan collections of *F. eboracensis* did not reveal such forms, but they are worth watching for in future collections.

Specimens examined. IONIA CO.: no locality, *Schnooberger 904* (MICH). IOSCO CO.: W of Oscoda, *Common 88* (MSC).

5. *Frullania riparia* Hampe ex Lehm. Map 5

This dioicous species is infrequent and widely scattered in Michigan. It is known from only four locations in the Lower Peninsula and one in the Upper Peninsula.

Frullania riparia is unlikely to be confused with any other Michigan *Frullania* because of its dioicous condition, explanate lobules, and large underleaves. The latter are frequently more than twice and may be as much as 3–4 times the width of the stem.

Examination of the eight Michigan collections available indicates that it grows mostly on the trunks and bases of trees. It has been found growing on *Carya* (1), *Quercus* (1), *Ulmus* (1), trunks and bases of unspecified trees (4), and the face of a dry limestone boulder (l).

Specimens examined. DELTA CO.: Summer Island, *Miller 4642* (MICH). GRATIOT CO.: Alma, *Schnooberger 303 & 354* (MICH). KALAMAZOO CO.: Augusta, *Ehrle 7350* (WMU). TUSCOLA CO.: Cass City, *Schnooberger 8954* (MICH). WASHTENAW CO.: Ann Arbor, *E.D. Wuist s.n.* (MICH); Ann Arbor, *Johnson 202 & 204* (MICH).

6. *Frullania oakesiana* Aust. Map 6

This autoicous species is infrequent to rare in Michigan. It is known only from the Upper Peninsula and the northernmost counties of the Lower Peninsula.

Frullania oakesiana may be readily recognized by its autoicous means of reproduction and by the large size of the lobule relative to the dorsal lobes of leaves. In ventral view, the lobule obscures more than half the area of the dorsal lobe.

The five collections examined indicated that it grows on the trunks of *Acer* (1), *Fraxinus* (1), *Populus* (1), and unspecified trees (2).

Specimens examined. BARAGA CO.: E of L'Anse, Sep 1938, *W.C. Steere s.n.* (MICH). CHEBOYGAN CO.: Wolff's Bog, 10 Jul 1951, *M. Fulford s.n.* (UMBS). CHIP-

PEWA CO.: Lower Tahquamenon Falls, *Miller 3973* (MICH). KEWEENAW CO.: Isle Royale, *Miller 7073* (MICH). PRESQUE ISLE CO.: S of Millersburg, *Miller 4076* (MICH).

7. *Frullania eboracensis* Gott. Map 7

This dioicous species is the most commonly encountered *Frullania* in Michigan. It is present on tree trunks and bases throughout the state and is rarely found on rocks. It is currently known from 54 of 83 counties and can be expected in all of the others.

Frullania eboracensis may be confused with the markedly less frequent *F. brittoniae*. *Frullania eboracensis* is clearly the most variable *Frullania* in Michigan (see Tables 2 & 3). Forms were seen which had lobules shaped like those of *F. brittoniae*. Frequently, several different lobule shapes can be seen on different mature parts of the same stem. Occasionally plants were seen with many explanate lobules on mature portions of the stem reminiscent of those of *F. inflata* or *F. riparia*. The underleaves are usually quite narrow and may lack teeth or have a single tooth on one or both lobes. In some collections caducous leaves commonly result in many denuded branches or whole plants. In others caducous leaves are entirely absent. Regenerants (in this case, gemmae) are present in some collections, most frequently those with caducous leaves, and entirely absent in others. The occurrence of gemmae in locations other than the margins of the dorsal lobes and their development into plantlets will be reported in a separate paper.

The extensive character overlap with *F. brittoniae*, discussed below under that species, is accompanied by an uncritical determination of some collections as *F. eboracensis*, apparently because it is very much more common and expected everywhere. It would be worthwhile to examine all accumulations of *F. eboracensis* collections throughout its range to locate additional material of *F. brittoniae*.

The 323 collections of *F. eboracensis* examined indicate that it grows most frequently on *Thuja* (46), *Quercus* (29), *Acer* (27), *Fraxinus* (27), and *Ulmus* (20) and less frequently on *Populus* (14), *Betula* (9), *Tilia* (6), *Fagus* (4), *Abies* (3), boulder in woods (3), limestone ledges (2), *Picea* (2), *Juglans* (1), *Carya* (l), *Cephalanthus* (1), and *Alnus* (1). A number of collections were marked hardwood forest (15) or tree trunk (58) without specifying the species of tree. The remaining collections (55) lacked sufficient label data to determine substrate.

Representative specimens examined. ALGER CO.: #1 Limestone Sink, 21 Jul 1955, *A.J. Sharp s.n.* (MICH). ALLEGAN CO.: Allegan State Game Area, *Ehrle 7514* (WMU). ALPENA CO.: ESE of Bolton, *Miller 4895* (UMBS). BARAGA CO.: L'Anse, Sep 1938, *W.C. Steere s.n.* (MICH). CHEBOYGAN CO.: Douglas Lake, *Merry 1764* (NM); N of Cheboygan, 18 Jul 1965, *H. Crum s.n.* (UMBS). CHIPPEWA CO.: Lower Tahquamenon Falls, *Miller 3972* (MSC). EMMET CO.: S of Levering, *Miller 3923* (MICH). GOGEBIC CO.: Dorothy Lake, *Vitt 1035* (UMBS). INGHAM CO.: East Lansing, *Harris 8567* (MSC). IOSCO CO.: Huron National Forest, *Engel 3691* (MSC). KALAMAZOO CO.: Augusta, *Ehrle 7351* (WMU). KALKASKA CO.: NNE of Kalkaska, *Schuster 38956* (MICH).

LEELANAU CO.: Glen Lake, *Darlington 348* (MICH). MACKINAC CO.: Bois Blanc Island, *Wynne 2509* (UMBS). MECOSTA CO.: Croton, 10 Oct 1937, *I. Schnooberger s.n.* (MICH). OSCEOLA CO., N of Reed City, *Ehrle 7520* (WMU). TUSCOLA CO.: Caro, *Wetmore 1061* (MSC). VAN BUREN CO.: South Haven, Jul 1910, *C.H. Kauffman s.n.* (MICH). WASHTENAW CO.: Waterloo Recreation Area, *Ehrle 7562* (WMU).

8. *Frullania brittoniae* Evans Map 8

This dioicous species is infrequent though widely scattered throughout Michigan on tree bark. It is quite variable. The plants may be green or red-brown, have lobules as wide or wider than long and compressed at their mouths, slightly or markedly tuberculate perianths, and two-lobed underleaves which vary from being longer than broad, with a single lateral tooth on each lobe, to broader than long and irregularly dentate. In Michigan, its variability overlaps in several ways with that of *F. eboracensis,* with which it is most likely to be confused.

The 24 collections examined indicate that it grows most frequently on *Acer* (6) and less frequently on *Fraxinus* (3), *Ulmus* (3), *Quercus* (2), *Thuja* (2), *Populus* (2), and *Betula* (1). The remaining collections (7) lacked sufficient label data to determine substrate.

The characters which have been used to differentiate between *F. brittoniae* and *F. eboracensis* are indicated in Table 1. They are not entirely satisfactory for discriminating between these species in Michigan. Even when taken in concert, problems remain. The first set of characters to come into question as effective discriminators were the characters of the perianth. At the time of his study of North American Frullanias, Evans (1897) placed forms with slightly tuberculate perianths in *Frullania virginica* Lehm. By 1906 he revised his earlier position by indicating that "the perianth in *F. eboracensis* is much less constant in its characters than had been supposed and that it not infrequently shows a tuberculate surface and also supplementary ridges" (Evans, 1906). Accordingly, he reduced *F. virginica* to synonymy under *F. eboracensis*. The variability of the perianth characters in Michigan material is shown in Table 2. Pronounced tuberculation occurs in 20% of the *F. brittoniae* (see Fig. 2) and none of the *F. eboracensis* collections examined. Sixty percent of the *F. eboracensis* perianths show no tuberculation at all (see Fig. 6) and only 7% of *F. brittoniae* lack tuberculation. Furthermore, the overlap at the "slightly tuberculate" character state is extensive, vis., 73% of *F. brittoniae* and 40% of *F. eboracensis* (see Fig. 4). The same phenomenon occurs with the length of the perianth beak. To further complicate matters, supplementary perianth ridges, long thought to be useful in discrimination occur in 100% of *F. brittoniae* perianths, but they also occur in 93% of *F. eboracensis* collections, effectively removing the presence of these ridges as a discriminator.

Characters of lobules, leaves, and underleaves (Table 3) likewise show considerable overlap. Lobule inflation with the mouth compressed is remarkably consistent in *F. brittoniae* (see Fig. 3), whereas in *F. eboracensis* the lobule mouths are mostly open (see Fig. 5). The lobules are as broad or

TABLE 1. Key characters used by various authors to separate *F. brittoniae (F.b.)* from *F. eboracensis (F.e)*. (1) Evans (1897), (2) Barbour (1902), (3) Frye & Clark (1947), (4) Schuster (1953), (5) Briel (1970), (6) Hong (1989).

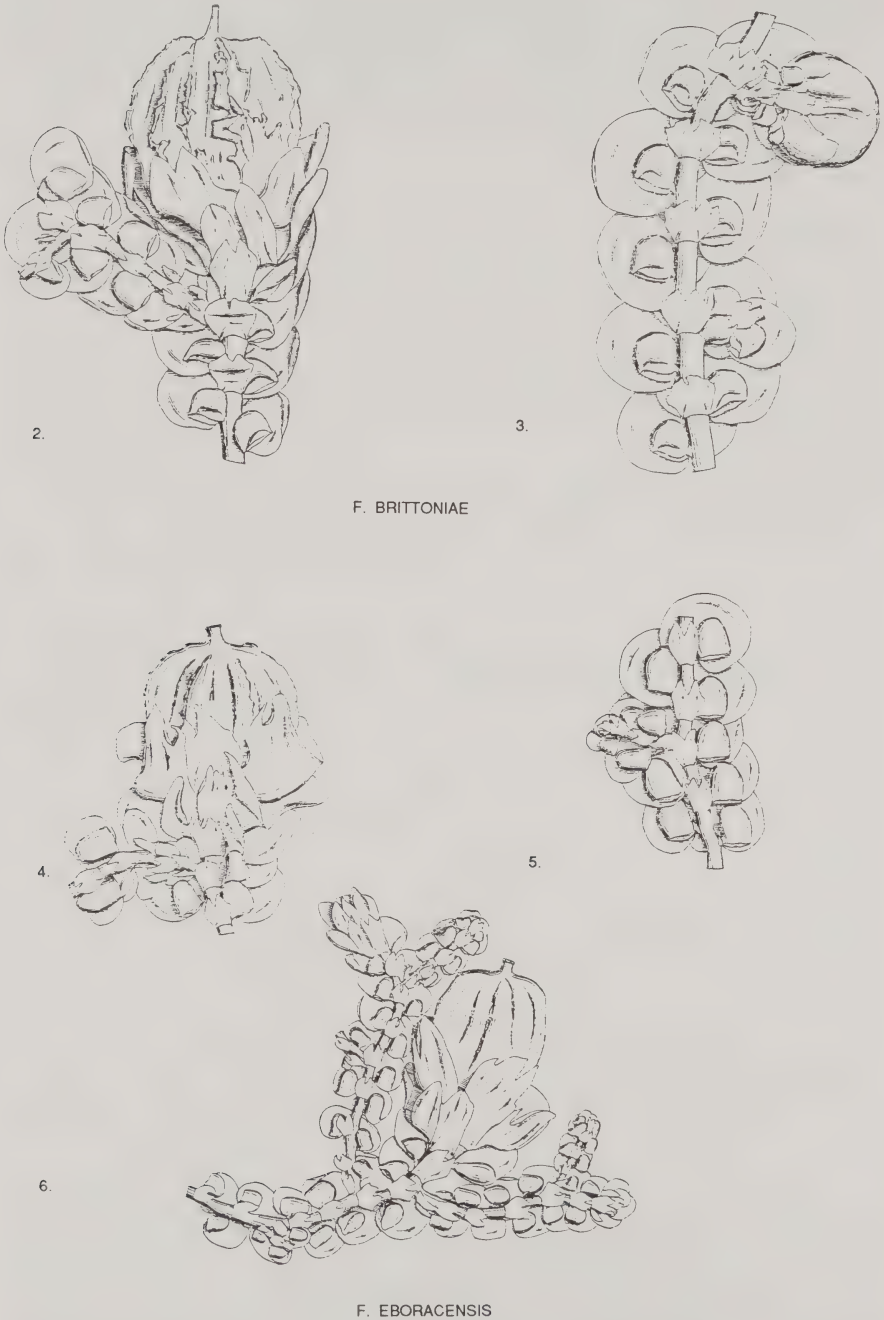
	(1)	(2)	(3)	(4)	(5)	(6)
Lobules compressed at base (*F.b*) vs. inflated throughout (*F.e.*)	×	×	×	×	×	×
Underleaves dentate or crenate (*F.b.*) vs. entire or unidentate (*F.e.*)	×	×		×	×	
Underleaves wider than long (*F.b.*)				×	×	
Underleaves shallowly divided (*F.b.*) vs. deeply divided (*F.e.*)						×
Cells with numerous intermediate thickenings (*F.e.*)				×		
Cells of middle of dorsal lobe of stem leaf with few (*F.b.*) vs. numerous (*F.e.*) intermediate thickenings			×			
Perianth tuberculate (*F.b.*) vs. smooth or nearly so (*F.e.*)	×	×		×		×
Perianth with (*F.b.*) vs. without (*F.e.*) distinct supplementary ridges	×			×		
Perianth beak long (*F.b.*) vs. moderate (*F.e.*)				×		

TABLE 2. Percent of Michigan collections of *F. brittoniae* and *F. eboracensis* showing various perianth character states.

	F. brittoniae n = 15 (%)	*F. eboracensis* n = 24 (%)
Perianth tuberculation		
Pronounced	20	0
Slight	73	40
None	7	60
Perianth supplementary ridges		
Present	100	93
Absent	0	7
Perianth beak		
Long (.15-.20 mm)	14	8
Moderate (.10 mm)	86	46
Short (.06-.09 mm)	0	46

broader than long in most *F. brittoniae* collections (see Figs. 2–3), but in *F. eboracensis* they are mostly longer than broad (see Figs. 4–6). The underleaves are uniformly narrow (see Figs. 4–6) without teeth or with a single tooth on one or both lobes of the underleaf in *F. eboracensis*; in *F. brittoniae* the underleaves may be broad, (see Figs. 2–3) as indicated in most keys and descriptions, or narrow and without teeth.

The data presented in Tables 2 & 3 are based on the examination of all



FIGURES 2–6. Perianth and vegetative characteristics of *F. brittoniae* and *F. eboracensis*. See text for explanation. The length of the bar is 0.5 mm. Drawings are from Evans (1897).

TABLE 3. Percent of Michigan collections of *F. brittoniae* and *F. eboracensis* showing various lobule, leaf, and underleaf character states.

	F. brittoniae n = 24 (%)	*F. eboracensis* n = 24 (%)
Lobule inflation		
Base compressed	100	17
Base open	0	83
Lobule length/width ratio		
0.7–0.9	24	0
1.0–1.2	63	42
1.3–1.8	13	58
Underleaves		
0–2 teeth, narrow	45	100
1–4 teeth, broad	55	0
Intermediate thickenings at leaf center under lobule		
Frequent	0	46
Infrequent	0	54
None	100	0

available Michigan material of *F. brittoniae* and comparable numbers of Michigan collections of *F. eboracensis*. It is possible that larger samples drawn from the entire range of both species might present a different view of the degree of overlap between them. Since there are no other published data that bear on this matter, the overlap described herein can be considered relevant only to Mighigan material. As indicated below, others have experienced difficulty in delimiting these species elsewhere. In time, the publication of additional data will indicate whether the overlaps described for the Michigan material are restricted to Michigan or applies elsewhere as well.

McGregor (1955), in commenting on these species in southeastern Kansas, indicated that they are often difficult to separate, especially when sterile or juvenile. He indicated that "they can usually be separated on the underleaf, the upper halves of which, in *F. brittoniae*, are usually dentate or dentate-crenate and are entire or bear one tooth in *F. eboracensis*." The double use of "usually" is clearly in order for the Michigan collections. McGregor (1955) further indicated that "The characters of the inflated lobules as given by Schuster (1953) to separate the two species seem to intergrade too much to be of value in our area." The same can be said for these two characters in the two species in Michigan. Schuster's (1953) comment that "*F. brittoniae* is very close to *eboracensis*, but can be generally recognized by the wider than long underleaves, whose lateral margins are almost uniformly dentate or crenate-dentate" does not work too well in Michigan, as the data in Table 3 show.

An additional character that has been used is the presence of intermedi-

ate cell wall thickenings. Both species have such thickenings abundantly in the outer third of the dorsal lobes and throughout the ventral lobules. The only area in which they differ is from the base of the dorsal lobe toward the center. This area, like the stylus, is difficult to see and requires patience. In order to effectively observe this area, which lies beneath the lobule when viewed from the ventral surface, either the lobules must be removed or lobes must be sought from which the lobules, for whatever reason, have not developed or have broken off. As indicated in Table 3, this area is devoid of intermediate thickenings in *F. brittoniae*. In *F. eboracensis* they vary from frequent to quite infrequent.

Two characters which should be more frequently used are the overall size of the plants and the presence or absence of caducous leaves and gemmae. *F. brittoniae* is usually larger than *F. eboracensis*. In the 24 collections of each measured, *F. brittoniae* exceeded 1.0 mm (up to 1.5 mm) in width 67% of the time and *F. eboracensis* was less than 0.9 mm (down to 0.6 mm) 87% of the time. Caducous leaves on branches devoid of leaves or nearly so are rather common in *F. eboracensis*, particularly in material collected during the late summer or fall. They are rarely seen in *F. brittoniae*. Gemmae likewise occur frequently in *F. eboracensis*, particularly along the margins of the dorsal lobes as described by Hicks (1974) but are rare in *F. brittoniae*.

The examination of type specimens was considered but rejected since the purpose of this study was floristic rather than revisionary. Nonetheless, several collections identified as either *F. brittoniae* or *F. eboracensis* by A.W. Evans were examined to sharpen the author's understanding of both species.

Given the extensive character overlap of these two species, as seen at least throughout the Michigan material, the question remains of whether *F. brittoniae* is a "good" species or should, like *F. virginica*, be reduced to synonymy beneath *F. eboracensis*. The answer to this question, on the basis of Michigan material, is a problematic "yes". It will probably be useful to continue to recognize both forms until such time as an extensive and intensive study of the sort conducted by Crandall-Stotler et al. (1987) for the purported subspecies of *F. tamarisci* can be conducted.

The 24 collections examined indicate that it grows most frequently on *Acer* (6) and less frequently on *Fraxinus* (3), *Ulmus* (3), *Quercus* (2), *Thuja* (2), *Populus* (2), and *Betula* (1). The remaining collections (7) lacked sufficient label data to determine substrate.

Specimens examined. ALGER CO.: Chatham, 28 Aug 1900, *C.J. Wheeler s.n.* (MSC). BARAGA CO.: Lower Baraga Lake, *Hermann 23771* (MICH). CHEBOYGAN CO.: between Douglas and Burt Lakes, *Miller 4765* (UMBS); near Douglas Lake, *Nichols & Ehlers 54* (MSC). CHIPPEWA CO.: Vermillion, 30 Jun 1919, *A. Povah s.n.* (MICH); Vermillion, 3 Jun 1914, *A. Povah s.n.* (MICH); Aspen Lake #2, *Vitt 849* (UMBS). DELTA CO.: Summer Island, *Miller 4725* (MICH). EATON CO.: Grand Ledge, *Ehrle 7063* (WMU). EMMET CO.: S of Levering, *Miller 3922* (MICH); Lake Shore Drive, 7 Jul 1940, *H. Gleason s.n.* (MICH). GRATIOT CO.: W of Alma, *Schnooberger 412* (MICH). HURON CO.: no locality, 8 Oct 1938, *I. Schnooberger s.n.* (MICH). ISABELLA CO.: N of Vestaburg, *Schnooberger 2269* (MICH); no locality, *Schnooberger 658* (MICH). KEWEENAW CO.: North Hay Bay, *Povah 311* (MICH). LUCE CO.: Upper Tah-

quamenon Falls, *Miller 4273* (MICH). MECOSTA CO.: Croton, *Schnooberger 138* (MICH). MONTCALM CO.: no locality, *Schnooberger 810 & 654* (MICH). ST. CLAIR CO.: Port Huron Game Area, *Schnooberger 9541* (MICH). WASHTENAW CO.: W of Ann Arbor, May 1941, *W.C. Steere s.n.* (MICH); SW of Ann Arbor, *Johnson 213* (MICH); Cascade Glen, Ann Arbor, *Johnson 232* (MICH).

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THE REVEGETATION POTENTIAL OF SELECTED MICHIGAN NATIVE AND NATURALIZED PLANT SPECIES ON FLY ASH DEPOSITS

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ABSTRACT

We analyzed 25 native and naturalized species, mostly grasses, from the Great Lakes region for their growth potential on 100% fly ash from coal-fired electric generating plants. Fertilizer ($NH_4H_2PO_4$) was added periodically to the watering cycle.

Comparative growth response of the plants was based on germination, seedling survival, and biomass production. We calculated an index of species performance based on the above data. Species showing the best overall performance were *Hordeum jubatum*, *Festuca arundinacea*, and *Elymus canadensis*. Among dicots tested, *Atriplex patula* and *Lotus corniculatus* grew better than other dicots.

INTRODUCTION

Restoration ecology is a subject that is currently receiving increasing attention for many reasons. A listing of recent published reports on this subject is contained in a paper by Hiebert (1990). Our report concerns preliminary steps which might be useful in producing a vegetation cover within an extreme environment—a deposit consisting of 100% fly ash.

Coal-fired electric generating plants produce fly ash as a by-product of combustion. Nationwide production of coal ash for 1983 was about 70 million tons (U.S. Environmental Protection Agency, 1988.). Limited commercial use of the ash by-product consigns the disposal of ash into large monofills; these are a source of considerable discussion and research. The chemistry of this particulate ash varies according to the coal source. Ash from coal relatively high in sulfur produces a higher acidic reaction than coal having a lower sulfur content. We studied an alkaline coal-ash derived from Montana coals producing a pH in the range of 9.5–10.5.

Plant species considered for their revegetation potential have often been investigated without regard to ecological verification, i.e., they might be naturalized or alien species capable of explosive growth once introduced into a new environment resulting in the occupation of niches to the exclu-

TABLE 1. Michigan native and naturalized species selected for study.
*—Voucher numbers are those of senior author and herbarium specimens have been deposited at BLH.
**—Indicates removal of species from further consideration due to slow growth rate or failure of seeds to germinate.

Species *Number*	Voucher *Number**	*Species Name and Common Name*
1**	8524	*Amaranthus powellii* S. Watson Pigweed
2	8560	*Atriplex patula* L. Spearscale
3	8525	*Carex praegracilis* W. Boott (no common name)
4	8528	*Chenopodium glaucum* L. Oak-leaved Goosefoot
5	8549	*Echinochloa crusgalli* (L.) Beauv. Barnyard Grass
6	8542	*Elymus canadensis* L. Canada Wild-rye
7	8522	*Festuca arundinacea* Schreber Tall Fescue
8	8521	*Hordeum jubatum* L. Squirrel-tail Grass
9	8557	*Kochia scoparia* (L.) Roth Summer Cypress
10	8559	*Leptoloma cognatum* (Schultes) Chase Fall Witch Grass
11	8515	*Lotus corniculatus* L. Bird's-foot Trefoil
12**	8519	*Melilotus officinalis* (L.) Desr. Yellow Sweet Clover
13	8536	*Muhlenbergia asperifolia* (Nees & Meyen) Parodi. Scratch Grass
14	8543	*Panicum virgatum* L. Switch Grass
15	8520	*Poa compressa* L. Canada Blue Grass
16	8529	*Polygonum lapathifolium* L. Heartsease
17	8537	*Portulaca oleracea* L. Purslane
18	8538	*Salicornia europaea* L. Glasswort
19**	8526	*Scirpus americanus* Pers. Threesquare
20**	8527	*Setaria viridis* (L.) Beauv. Green Foxtail
21	8558	*Solidago sempervirens* L. Seaside Goldenrod
22	8547	*Spartina pectinata* Link Cordgrass
23	8548	*Sporobolus asper* (Michaux) Kunth Rough Dropseed
24**	8516	*Trifolium hybridum* L. Alsike Clover
25	8546	*Vernonia missurica* Raf. Missouri Ironweed

sion of native species. We sought to study indigenous and naturalized salt-tolerant vascular plant species, some of which are termed "halophytes" (Catling and McKay 1981, Reznicek 1980, and Ungar 1982). The species we investigated would be submitted to a substrate consisting of 100% fly ash. Species growing best under these conditions would be prime candidates for revegetation efforts in the reclamation of fly ash deposits without the need to ameliorate the edaphic conditions in ash with agents such as clay or top soil. As such, they would provide a crucial first step in the establishment and primary succession of a plant community on these particular non-soil substrates.

METHODS

We selected 25 candidate species (Table 1) based upon literature citations of halophytic plants and on personal observations of Michigan saline sites such as highway median strips containing salt runoff from winter snow control application. Seeds for all experiments were wild-collected along roadsides and in native habitats or from fly ash deposits in southeastern Michigan during the summer and fall, stored at room temperature, and planted the same year.

Voucher specimens are on deposit in the Billington Herbarium at the Cranbrook Institute of Science (BLH).

To simulate the relatively lengthy natural weathering which eventually reduces the high pH of freshly produced fly ash we washed the fly ash with tap water in a cement mixer followed by a 24 hour exposure to running water, and finally screened the ash through 1/2 inch mesh wire to remove larger clumps. However, carbonates that were likely formed by $CaO + CO_2 \rightarrow CaCO_3$ continued to leach out of the fly ash and the pH remained relatively high (ca. 9.5). We believe this high pH caused the low success of most species tested.

The experimental design (Fig. 1) involved comparative growth studies under greenhouse conditions at the University of Michigan's Matthaei Botanical Gardens. For each of 25 selected species, 1,000 seeds were planted, 500 on fly ash (treatment) and 500 on the soil substitute Metro-Mix (control). Each lot of 500 seeds was divided equally and planted among four plastic 11″ x 11″ × 2″ flats (i.e., eight flats per species) and 21 days later, percent germination data were recorded from these flats. Up to day 21, all flats were watered one to two times daily (designated "wet"), hence the substratum did not dry out. After day 21, a second water regime was initiated, designated "dry" where water was applied every other day. Of the eight flats per species two were wet ash, two dry ash, two wet control and two dry control. After a further 24 days of growth (day 45), the seedling height and seedling survival data were recorded. Selected seedlings of the nine surviving species on water-washed fly ash were transplanted to plastic 6″ × 6″ pots which contained the same water-washed fly ash that was used for the flats. We transplanted to encourage greater root development through more constant moisture availability. Where quantities were available, only the most robust individuals were transplanted. Where quantities were limited, all material was transplanted. Similar transplanting was done for the respective control plants. Three seedlings were placed in each pot, and five pots were made up from each flat for a total of 40 pots (20 ash + 20 Metro-Mix) and 120 seedlings for each of the surviving species where material permitted. After an additional 135 days (approximate) (i.e., day 180+), the above-soil parts were harvested and weighed to determine above-ground biomass. During all this time, only water and fertilizer (monobasic ammonium phosphate, $NH_4H_2PO_4$) were added to each substrate. Fertilizer was applied at the rate of 150 mg/L and at a rate of 500 ml/pot, or flat, per month.

Statistical comparison of % germination results was made using a Z test which allows species-by-species comparison of the % germination mean for fly ash and that for Metro-Mix. The Z value is calculated as follows:

$$Z = \frac{p_m - p_a}{\sqrt{\frac{S^2}{N_m} + \frac{S^2}{N_a}}}$$

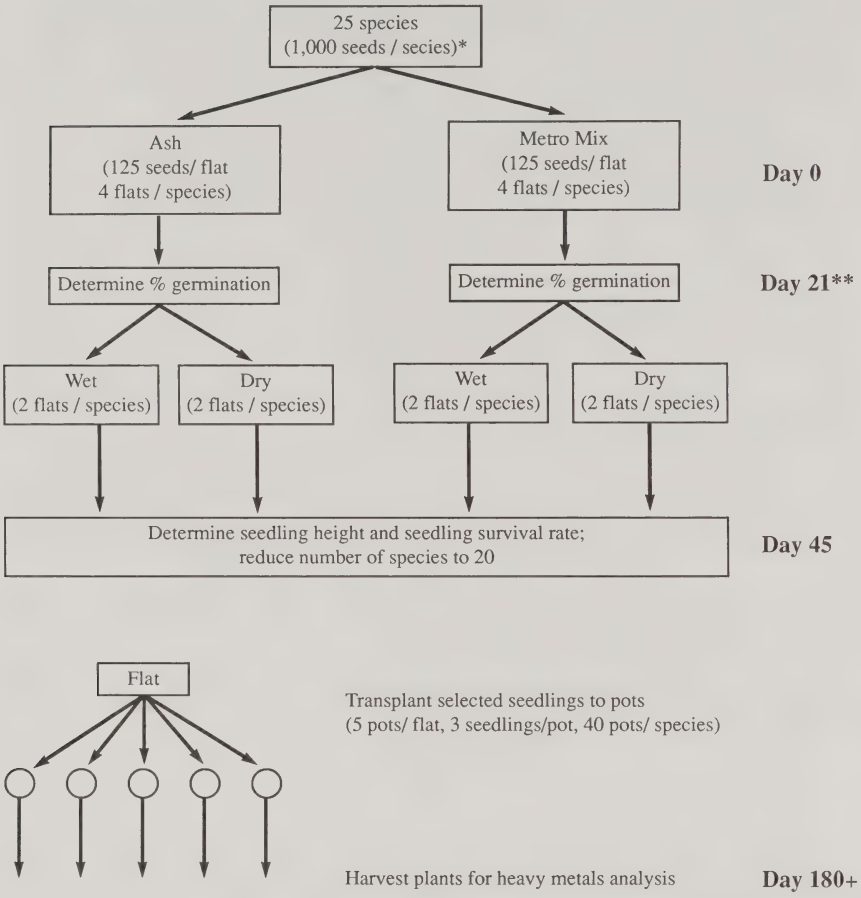
where p_m = % germination on Metro Mix
p_a = % germination on fly ash
N_m = number of seeds tested on Metro Mix
N_a = number of seeds tested on fly ash
S^2 = variance estimate = (pooled p) (100 - pooled p)

$$\text{pooled } p = \frac{A_m + A_a}{N_m + N_a} \times 100$$

A_m = number of seeds germinating on Metro Mix
A_a = number of seeds germinating on fly ash

The Z-value represents the difference between the mean % germination of the two different substrata in terms of standard errors.

Fig. 1. Experimental Design Outline



* Each 11" x 11" flat received 125 seeds, equalling 8 flats per species.

** All flats were kept "wet" up to day 21, i.e. watered 1-2 times daily so as to prevent drought.

RESULTS AND DISCUSSION

Seed germination results after 21 days are shown in Table 2. The seeds used in this study were not vernalized. Most species germinated, even on fly ash, within seven days of planting. After 21 days, seeds of only two of the 25 species tested had failed to germinate on fly ash. All of the species had higher % germination on Metro-Mix than on fly ash and the differences

TABLE 2. Seed germination on water-washed ash and on Metro-Mix after 21 days in terms of counts and percents. Data are based upon 1,000 seeds/species, i.e. 500 seeds each for fly ash and Metro-Mix.

Species Name	Fly Ash		Metro-Mix			
	Number	Percent	Number	Percent	Z-value	Significance
Amaranthus powellii	67	13	145	29	6.035	P < .01
Atriplex patula	117	23	279	56	10.475	P < .001
Carex praegracilis	6	1	16	3	2.156	P < .05
Chenopodium glaucum	314	63	397	79	5.790	P < .001
Echinochloa crusgalli	184	37	206	41	1.426	ns
Elymus canadensis	405	81	442	88	3.250	P < .005
Festuca arundinacea	384	77	457	91	6.313	P < .001
Hordeum jubatum	416	83	446	89	2.751	P < .01
Kochia scoparia	390	78	461	92	6.305	P < .001
Leptoloma cognatum	38	8	133	27	7.979	P < .001
Lotus corniculatus	254	51	283	57	1.839	ns
Melilotus officinalis	13	3	20	4	1.239	ns
Muhlenbergia asperifolia	52	10	136	27	6.799	P < .001
Panicum virgatum	2	0.4	20	4	3.881	P < .001
Poa compressa	105	21	390	78	18.026	P < .001
Polygonum lapathifolium	16	3	22	4	0.992	ns
Portulaca oleracea	74	15	303	61	14.942	P < .001
Salicornia europaea	20	4	34	7	1.959	ns
Scripus americanus	0	0	0	0	0.000	ns
Setaria viridis	0	0	28	6	5.367	P < .001
Solidago sempervirens	5	1	92	18	9.296	P < .001
Spartina pectinata	7	1	9	2	0.504	ns
Sporobolus asper	43	9	290	58	16.573	P < .001
Trifolium hybridum	35	7	60	12	2.696	P < .01
Vernonia missurica	1	0.2	2	0.4	0.578	ns

were mostly significant ($P < 0.05$). Several of the species, however, had substantial germination success on fly ash. For example, six species had over 50% germination on fly ash compared to nine species on Metro-Mix. For eight of the species, there was no significant difference between the two treatments in terms of % germination, but six of these had very low (less than 10) % germination, even on Metro-Mix.

After 45 days growth on fly ash, most populations had begun to decline (Table 3) as compared to their day 21 numbers (Table 2). This was due largely to the failure of adequate root development, probably because of excessive alkalinity. In contrast, seven species listed in Table 3 had higher numbers of seedlings present at day 45 than on day 21 due to continued germination after day 21. Hence, the data in Table 3 represent a combination of continued seed germination and survival of previously germinated seeds. These seven species producing higher counts (hence % survival values over 100) were sedge (*Carex praegracilis*), scratch grass (*Muhlenbergia asperifolia*), switch grass (*Panicum virgatum*), heartease (*Polygonum*

TABLE 3. Number of seedlings present after 45 days on wet and dry fly ash and on wet and dry Metro-Mix (M.M.) out of 500 original seeds. Species names followed by a footnote showed a significant interaction between substratum type and water treatment as determined by X^2 analysis: 1 = $P < 0.05$; 2 = $P < 0.01$; 3 = $P < 0.001$; all others are not significant.

Species	Wet M.M.	Wet Ash	Dry M.M.	Dry Ash
Amaranthus powellii[1]	72	5	69	0
Atriplex patula[3]	199	69	185	15
Carex praegracilis	15	6	5	2
Chenopodium glaucum[3]	205	137	186	3
Echinochloa crusgalli[3]	107	70	113	29
Elymus canadensis	231	182	221	143
Festuca arundinacea[3]	174	173	134	67
Hordeum jubatum[1]	174	178	164	119
Kochia scoparia[1]	234	150	225	104
Leptoloma cognatum[2]	111	27	79	6
Lotus corniculatus	104	40	141	49
Melilotus officinalis	10	2	11	2
Muhlenbergia asperifolia	78	35	84	24
Panicum virgatum	27	6	19	5
Poa compressa	166	31	137	16
Polygonum lapathifolium[1]	40	30	31	8
Portulaca oleracea[3]	71	9	194	0
Salicornia europaea[2]	35	19	36	5
Scripus americanus	1	0	0	0
Setaria viridis	9	0	18	0
Solidago sempervirens	45	3	49	1
Spartina pectinata	15	6	10	2
Sporobolus asper	136	22	101	7
Trifolium hybridum	35	2	25	5
Vernonia missurica	15	4	5	0

lapathifolium), glasswort (*Salicornia europaea*), cordgrass (*Spartina pectinata*), and Missouri ironweed (*Vernonia missurica*).

In Table 4 are presented seedling height results after 45 days growth. Seedlings < 1.0 cm in height were scored as zero height. Such seedlings were not included in the means of treatments with < 10 total plants. *Elymus canadensis*, *Festuca arundinacea*, *Hordeum jubatum*, *Sporobolus asper*, and *Echinochloa crusgalli*, grew tallest in both wet and dry regimes (Table 4); all five species are grasses (monocots). Every species tested grew to a greater height on Metro-Mix than on fly ash whether wet or dry regime. Seventeen of the 20 species had seedling heights on Metro-Mix that were at least an order of magnitude greater than those on fly ash. The tallest species on fly ash (*Elymus canadensis*) at 6.2 cm was only one-third the height of that same species growing on Metro-Mix. Only five species had seedling heights averaging over 2 cm on fly ash compared to 23 species on Metro-Mix. Significant interactions ($P < 0.05$) between moisture treatment and substratum type were observed for several species, marked with asterisks in Table 4. For species not so marked there was no significant difference

TABLE 4. Seedling height (mean in cm ± SE with sample size in parentheses) for plants at day 45 after sowing. Species marked with an asterisk had a significant ($P < 0.05$) interaction between moisture treatment and substratum type as determined by two-factor ANOVA.

Species	Fly Ash: Wet	Fly Ash: Dry	Metro-Mix: Wet	Metro-Mix: Dry
*Amaranthus powellii**	1.0±0.0 (4)	0	21.1±2.35 (20)	21.8±1.89 (20)
Atriplex patula	1.3±0.11 (20)	1.7±0.26 (10)	17.9±1.53 (20)	20.6±1.63 (20)
*Carex praegracilis**	1.0±0.0 (2)	0	13.1±1.70 (14)	8.3±0.63 (4)
*Chenopodium glaucum**	1.0±0.0 (20)	0	21.9±0.85 (20)	17.7±1.05 (20)
*Echinochloa crusgalli**	2.7±0.13 (20)	2.6±0.15 (17)	39.1±2.31 (20)	46.3±1.80 (20)
*Elymus canadensis**	6.2±0.26 (20)	4.7±0.26 (20)	21.6±0.74 (20)	19.5±0.63 (20)
Festuca arundinacea	5.1±0.28 (20)	4.7±0.28 (16)	25.3±1.56 (20)	27.5±1.45 (20)
Hordeum jubatum	3.4±0.34 (20)	3.9±0.24 (20)	27.3±1.37 (20)	29.5±1.00 (20)
Kochia scoparia	1.9±0.12 (20)	1.8±0.16 (20)	19.6±1.16 (20)	17.2±1.07 (20)
Leptoloma cognatum	1.4±0.12 (19)	1.3±0.21 (6)	32.0±3.56 (20)	39.3±1.49 (20)
Lotus corniculatus	1.4±0.11 (20)	1.5±0.12 (17)	19.2±1.35 (20)	18.9±1.09 (20)
*Melilotus officinalis**	0	1.0±0.0 (2)	21.1±2.22 (10)	20.6±2.66 (11)
*Muhlenbergia asperifolia**	1.0±0.0 (18)	1.0±0.0 (14)	16.8±1.93 (20)	24.6±0.65 (20)
*Panicum virgatum**	1.3±0.25 (4)	1.6±0.24 (5)	8.4±1.63 (18)	27.4±3.89 (16)
Poa compressa	1.2±0.09 (20)	1.3±0.15 (10)	31.0±1.40 (20)	31.9±1.83 (20)
*Polygonum lapathifolium**	1.0±0.0 (20)	1.0±0.0 (9)	7.1±1.38 (20)	14.9±2.67 (20)
*Portulaca oleracea**	0	1.0±0.0 (3)	13.5±0.44 (20)	12.1±0.76 (19)
Salicornia europaea	1.0±0.0 (16)	1.0±0.0 (13)	4.5±0.56 (20)	5.6±0.65 (20)
*Scripus americanus**	0	0	0	0
*Setaria viridis**	0	0	62.3±8.08 (8)	63.3±2.93 (16)
*Solidago sempervirens**	1.0±0.0 (7)	1.0 (1)	16.2±1.22 (20)	18.4±1.15 (20)
*Spartina pectinata**	1.9±0.26 (7)	2.0 (1)	10.0±2.18 (12)	19.8±3.14 (10)
Sporobolus asper	3.5±0.37 (10)	3.0±0.68 (6)	31.3±1.03 (20)	29.5±0.90 (20)
Trifolium hybridum	1.0±0.0 (2)	1.0±0.0 (4)	20.5±1.74 (20)	21.5±1.05 (18)
*Vernonia missurica**	0	0	1.2±0.15 (14)	1.4±0.40 (5)

between moisture levels but there were highly significant differences ($P < 0.001$) between Metro-Mix and ash treatments.

Seedling Survival on Fly Ash

After seven and a half months of contact with fly ash, half the species had no surviving seedlings (Table 5). Four of these had low germination rates (< 5%): *Carex praegracilis*, *Panicum virgatum*, *Solidago sempervirens*, and *Vernonia missurica*. However, *Chenopodium glaucum* and *Kochia scoparia* had germination rates in excess of 50% but their seedlings subsequently died. Most survivors (110 of 158 = 70%) had been grown on the wet bench—i.e., watered daily. Most surviving seedlings were from three grasses *Hordeum jubatum*, *Festuca arundinacea*, and *Elymus canadensis*. Their combined total of 129 represents 82% of all surviving seedlings. Two of these three species, *Elymus canadensis* and *Hordeum jubatum*, had similar survival rates on both wet and dry bench conditions (Table 5).

Best growth in terms of height after seven and a half months, in decreasing order, were: *Festuca arundinacea*, *Hordeum jubatum*, and *Elymus canadensis*. Seedlings of all other species were smaller in size and/or num-

TABLE 5. Number of plants surviving on water-washed fly ash from 250 seeds at start. An asterisk indicates survivors were of questionable viability. Five of the original 25 species tested were eliminated from this table because of zero germination or zero survival.

Species	Wet Fly Ash Number Germinated	Wet Fly Ash Number Surviving	Dry Fly Ash Number Germinated	Dry Fly Ash Number Surviving	Total Survivors	Percent Survivors
Atriplex patula	22	3	95	1	4	3.4
Carex praegracilis	3	0	3	0	0	0
Chenopodium glaucum	127	0	187	0	0	0
Echinochloa crusgalli	89	1	95	0	1	0.5
Elymus canadensis	221	14	184	9	23	5.7
Festuca arundinacea	198	43	186	4	47	12.2
Hordeum jubatum	191	27	225	32	59	14.2
Kochia scoparia	194	0	196	0	0	0
Leptoloma cognatum	26	0	12	0	0	0
Lotus corniculatus	107	0	147	2	2	0.8
Muhlenbergia asperifolia	27	6	25	0	6	11.5
Panicum virgatum	0	0	2	0	0	0
Poa compressa	53	11	52	0	11	10.5
Polygonum lapathifolium	9	0	7	0	0	0
Portulaca oleracea	57	0	17	0	0	0
Salicornia europaea	13	0	7	0	0	0
Solidago sempervirens	2	0	3	0	0	0
Spartina pectinata	5	2	2	0	2	28.6
Sporobolus asper	31	3	12	0	3	7.0
Vernonia missurica	0	0	1	0	0	0

ber. No seedlings were over 10 cm tall. Following eight months of growth the largest surviving seedlings of these plants were transplanted to pots. All species survived the transplanting except for *Echinochloa crusgalli*. After an additional five weeks of growth the total number of plants of each species was tabulated (Table 6).

We found that among the 25 species sampled, those that grew best (i.e., based upon stems and leaves) on water-washed fly ash, in decreasing order were: *Festuca arundinacea*, *Hordeum jubatum*, *Poa compressa*, and *Muhlenbergia asperifolia*. Had the experiment run longer and/or had a more appropriate fertilizer been used (i.e. one which made nitrate directly available) we believe these four species would have flowered and set seed. At the time (393 days since germination) however, only *Poa compressa* had begun to flower.

Performance Index: Water-washed Ash

A performance index for twelve species based on the rank sum of each species in terms of the three performance indicators is presented in Table 7. For example, *Festuca* ranked fourth in terms of percent germination, second in height, and second in survival. Its performance index is 4 + 2 + 2 = 8. In the case of ties, each species was given the tie value. For example, *Kochia* ranked third for percent germination, seventh for height and was in

TABLE 6. Numbers of seedlings surviving 35 days after transplanting (3 plants/pot) into water-washed fly ash.

Species	No. Pots	Total No. of Plants
Atriplex patula	1	1
Carex praegracilis	1	3
Echinochloa crusgalli	1	1(dead)
Elymus canadensis	5	21
Festuca arundinacea	5	36
Hordeum jubatum	6	42
Muhlenbergia asperifolia	2	6
Poa compressa	2	11
Sporobolus asper	1	2

TABLE 7. Index of performance for the 12 highest-ranking species (best = 1) based on their ranks from the three performance indicators: % germination, seedling height, and long-term survival. Values in the rank sum column are the sums of the 3 performance indicator ranks. Species marked with an asterisk had zero long-term survival hence are of doubtful utility for revegetation.

Rank	% Germination	Height	Long-term Survival	Performance Index	Rank Sum
1	*Hordeum*	*Elymus*	*Hordeum*	*Hordeum*	5
2	*Elymus*	*Festuca*	*Festuca*	*Elymus*	6
3	*Kochia*	*Hordeum*	*Elymus*	*Festuca*	8
4	*Festuca*	*Sporobolus*	*Poa*	**Kochia*	20
5	*Chenopodium*	*Echinochloa*	*Muhlenbergia*	*Echinochloa*	21
6	*Lotus*	*Spartina*	*Atriplex*	*Atriplex*	22
7	*Echinochloa*	*Kochia*	*Sporobolus*	*Lotus*	23
8	*Atriplex*	*Atriplex*	*Spartina*	*Poa*	24
9	*Poa*	*Lotus*	*Lotus*	*Sporobolus*	24
10	*Portulaca*	*Panicum*	*Echinochloa*	**Chenopodium*	28
11	*Muhlenbergia*	*Leptoloma*	**Chenopodium*	*Muhlenbergia*	29
12	*Sporobolus*	*Poa*	**Kochia*	*Spartina*	32

a ten-way tie for tenth for survival. Although listed in the table as twelfth for survival, its rank sum was actually 3 + 7 + 10 = 20. The list is arbitrarily limited to the 12 species with the highest performance indices. Of the other species tested, most had zero long-term survival hence are not likely to be useful candidates for revegetation. Two species shown in Table 7, *K. scoparia* and *C. glaucum*, also had zero long-term survival, which makes them relatively poor candidates for revegetation despite moderately high rankings for one or both of the other two performance indicators.

Perhaps a better measure of desirability for fly ash revegetation, not considered in this study, is the overall biomass produced. *Festuca* would probably produce the most biomass. Our plants were not carried to maturity and biomass data should be based upon a large sample size. It would also be desirable to measure rhizome and tiller growth for each species. Another consideration of species desirability is the relative tendency of each species to selectively take up high concentrations of heavy metals.

CONCLUSION

In this study we have demonstrated the feasibility of growing selected Michigan plants on treated fly ash under greenhouse conditions. Of the 25 species screened, three grasses (*Hordeum jubatum*, *Festuca arundinacea*, *Elymus canadensis*) performed best in terms of an index based on percent germination, seedling height, and long-term survival. Their overall performance remained highest on water-washed ash. The next best performers were *Spartina pectinata* and *Sporobolus asper.* (Extensive data tables, i.e. appendices, available upon request from the authors.)

Based upon these findings we suggest further research:

1) A field test based on approximately one acre with two types of western ash; a) naturally aged for at least one year and b) acid-treated ash (tech. grade H_2SO_4).
2) Incorporate the best growing species based upon this study, into a seed mix and sow by hydro-seeding in November with rainfall as the only water source; evaluate results in May and October for two successive years.
3) Carry out metal analyses on mature plant tissues, three replicates/species.
4) Carry out total per acre cost analysis of this procedure including cost of obtaining seeds.

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AN INTERSUBGENERIC HYBRID OF AUREOLARIA FLAVA AND A. PEDICULARIA

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ABSTRACT

An intersubgeneric hybrid of two widespread *Aureolaria* species is described in detail. The new hybrid has low pollen stainability and is mostly intermediate in morphology between its parents, *A. flava* ($2n = 24$) and *A. pedicularia* ($2n = 28$). However, the hybrid has a unique pattern of pubescence characterized by eglandular, multiseriate hairs on two of the four faces of the quadrate stems and inflorescence branches. This is the first documentation of natural hybridization in the genus.

INTRODUCTION

The genus *Aureolaria* Raf. is represented in the eastern United States by 10 species in 2 distinct subgenera, *Aureolaria* and *Panctenis* Pennell (Pennell 1929, 1935). The subgenera differ in a number of vegetative and floral features, as well in annual or perennial duration.

In Michigan, the genus includes *A. pedicularia* (L.) Raf. var. *ambigens* (Fern.) Farw. in the subgenus *Panctenis*, and *A. flava* (L.) Farw. and *A. virginica* (L.) Pennell in the subgenus *Aureolaria*. All three are widely distributed in the southern half of the lower peninsula as far north as Grand Traverse and Iosco counties, and two occur also in Menominee County in the upper peninsula. Outside of the state, all three species range throughout the eastern United States. *Aureolaria pedicularia* and *A. flava* are particularly frequent in well drained soils of oak-dominated forests, where they occasionally grow intermingled.

In 1981, Pippen and graduate student James Ayres discovered an odd plant with striking features. The plant was situated in a mixed colony of the two species at Gourdneck State Game Area, Kalamazoo County, Michigan. Its previous year's dead stems, late flowering relative to individuals of the two species, and intermediate morphology suggested that it was a hybrid of *A. flava* and *A. pedicularia*.

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METHODS

In August of 1982, Pippen returned to the site and pressed one of the floriferous stems for later study. Morphological comparisons among the putative hybrid, *A. flava*, and *A. pedicularia* were made using specimens at KE, MICH, MSC, and WMU.

Pollen stainability, presumed to be an adequate measure of viability, was determined from both herbarium specimens and flowers preserved in FAA of the two species, and from the dried specimen of the putative hybrid. In each case portions of mature anthers were macerated in iron-acetocarmine stain and checked for well-formed, strongly stained grains under 400× magnification of a light microscope. Counts were made from one to three flowers on each dried or preserved specimen, and included at least 200 grains per flower in most cases. A total of 1604 pollen grains were counted from seven flowers on three specimens for *A. pedicularia*; 2230 pollen grains, from twelve flowers on five specimens for *A. flava*; and 200 pollen grains, from two flowers on the single specimen of the putative hybrid. Pollen stainability was calculated per specimen as the cumulative ratio of well-formed, strongly stained grains to the total number of grains counted. Average pollen stainability was calculated per taxon by averaging all the values determined for specimens of that taxon.

RESULTS AND DISCUSSION

Comparison of the putative hybrid with specimens of *A. flava* and *A. pedicularia* (Table 1) demonstrates that the morphology of the Gourdneck State Game Area plant falls outside the range of variation expressed in either species, but is mostly intermediate between the two (Table 1, Fig. 1). However, certain characteristics tend toward character states typically found in only one of the putative parents, whereas other characteristics are not found in either parent.

The hybrid differs from its putative parents in having strongly quadrate stems, compared with the typically terete or slightly compressed ones of the parents. Furthermore, the putative hybrid has a stem pubescence pattern superficially unlike that of either parent. In *A. flava*, the stem is completely glabrous (at most with scattered long hairs) and is usually strongly glaucous but in *A. pedicularia* var. *ambigens* it is heavily villous, with long gland-tipped hairs intermixed with short, non-glandular ones. The quadrate stem has retrorse pubescence on the faces, with the angles glabrous. The hairs are multiseriate, glandless, and much shorter (mostly under 1 mm long) than the longest ones (often over 2 mm) of *A. pedicularia*.

Pollen stainability averages 93% in *A. flava*, 4% in the putative hybrid, and 97% in *A. pedicularia*. Pollen of *A. flava* and *A. pedicularia* is virtually all well-formed and highly stained, whereas pollen of the putative hybrid is predominately misshapen and unstained. Occasional very large, round, heavily stained pollen grains are found that may be unreduced mother cells. High pollen abortion would be expected in a hybrid derived from parents with different chromosome numbers, *A. flava* reportedly having $2n = 24$ chromosomes and *A. pedicularia*, $2n = 28$ chromosomes (Canne 1981).

Morphological intermediacy in most characters, very low pollen stainability presumably representing nearly complete pollen grain abortion, and location within a mixed colony of *A. flava* and *A. pedicularia*, lend convincing evidence for the hypothesis that the variant plant of Gourdneck

TABLE 1. Morphological comparison of *Aureolaria flava,* putative hybrid ("variant"), and *A. pedicularia* based on Michigan specimens.

CHARACTER	*FLAVA*	VARIANT	*PEDICULARIA*
Morphology Stems	Terete, essentially glabrous, glaucous	Quadrate, glabrous along angles, densely hirtellous with short retrorse, multicellular hairs on two faces	Terete, densely villous with short and long, spreading, multicellular glandular hairs throughout
Leaves	Lanceolate to elliptic, cuneate to truncate at base, commonly pinnatifid	Broadly lanceolate, cuneate to subcordate at base, pinnatifid	Lance-ovate to ovate, cordate at base, deeply pinnatifid to bipinnatifid
Inflorescence bracts	Linear-lanceolate to lanceolate, broadest near middle, entire	Lance-ovate, broadest near middle, pinnatifid	Lance-ovate to ovate, broadest near base, pinnatifid
Pedicels	4-7 mm	8-9 mm	12-28 mm
Calyx tube	Glabrous, hemispherical	Sparsely pubescent with multicellular, glandular hairs, truncate	Densely villous with multicellular, glandular hairs, funnelform
Calyx lobes	2-6 mm, entire	ca. 6 mm, entire to pinnatifid	6-10 mm, pinnatifid
Corolla	26–40 mm, glabrous externally	20-31 mm, sparingly puberulent externally	21-39 mm, with dense short and long multicellular, glandular hairs externally
Duration	perennial	perennial (biennial?)	annual (biennial?)
Pollen stainability	85–99%	3-5%	96-99%

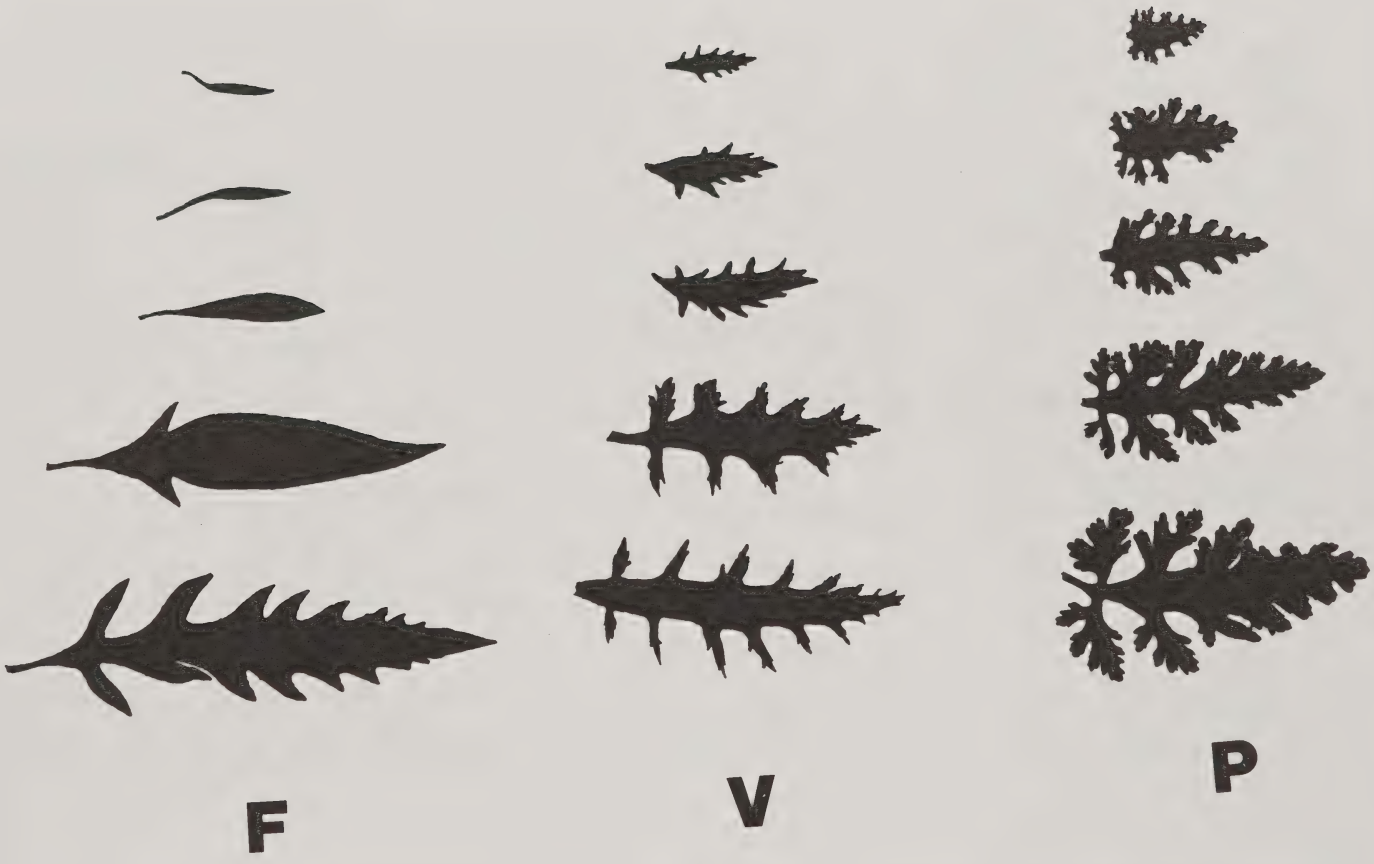

FIGURE 1. Silhouettes of inflorescence bracts (top 2), upper leaves (third and fourth), and lowest leaves (fifth) of the species and putative hybrid. F = *A. flava*, V = variant (putative hybrid), and P = *A. pedicularia*.

State Game Area is an interspecific hybrid of the two species. A collection from Bay County deposited at MICH (Bay City, Waterworks Park, woods, 6 Aug 1931, *R. R. D[reisbach] 7414*), is identical in morphology to the Gourdneck Game Area specimen, and represents a second location for the putative hybrid.

This is the first documentation of a natural hybrid in the genus *Aureolaria*, and involves species traditionally segregated into different subgenera. The hybrid described above will likely be found elsewhere in the sympatric range of the species, but probably not as persistent populations owing to its sterility—it is an evolutionary "deadend". Nevertheless, the occurrence of hybridization between species that have traditionally been assigned to different subgenera suggests that segregation of species at the subgeneric level in *Aureolaria* may not be justified.

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NOTEWORTHY COLLECTIONS

ONTARIO

SOLIDAGO ULMIFOLIA Muhl. (Asteraceae). Elm-leaved Goldenrod.

Previous knowledge. This species has been reported only once before in Ontario (Semple & Ringius 1983a, 1983b), based on a specimen from Cairngorm, about 40 km west-southwest of London, Middlesex County, collected in 1935 (UWO). Elsewhere it is widely distributed across eastern North America south of Canada. It is not known from any other Canadian province (Scoggan, 1978).

Significance. This collection documents the continued presence of *S. ulmifolia* in Ontario, and adds a new county record. Since the two Ontario collections are about 150 km apart, the species should be sought elsewhere in southwestern Ontario. The new collection adds another rare species to the long list of rarities known from the Stone Road Alvar (an alvar is an area of level, limestone rock covered by thin soil and vegetated by a sparse yet distinctive dry grassland plant cover) on Pelee Island (Oldham 1983, 1988). Because the 1935 Ontario record was so far from other known sites and because the collection came from "fields and roadsides," Semple & Ringius (1983a) suggested that it might have been introduced from further south. Since the disjunction of the 1935 collection is now reduced substantially and since the recent discovery involves a natural habitat including

many rare native species, it seems appropriate to treat *S. ulmifolia* as a native species in Ontario rather than as an introduction.

Diagnostic characters. Solidago ulmifolia is distinguished by the following combination of traits: branching caudex (not creeping rhizomes), petiolate basal leaves often larger than the stem leaves, leaves which are at least hairy on the lower surface mid vein and main lateral veins. It is similar to *S. arguta* which has either hairless leaves or leaves with upper surfaces merely scabrous. It is similar to *S. rugosa* which has creeping rhizomes, more hairy leaves, and basal leaves that are smaller than the mid stem leaves.

ONTARIO, ESSEX CO.: Federation of Ontario Naturalists Nature Reserve, Stone Road Alvar, Pelee Island, 12 Aug 1989, *Oldham 9971* (WAT). Uncommon in scrubby dry woods over limestone bedrock.

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TRIFOLIUM REFLEXUM L. (BUFFALO CLOVER: LEGUMINOSAE) IN OHIO, ITS HISTORY AND PRESENT STATUS

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Trifolium reflexum L. (buffalo clover) is a beautiful and robust, erect, non-stoloniferous annual or biennial (possibly perennial; see Isely 1990) species of native clover. Stems branch from the base and also above, and range from densely pubescent to glabrate. Stipules are broad-based, ovate-acute, and serrate. The petiolate leaves range from 3–7 cm wide and long, with denticulate margins. Flowers, upright at first but soon reflexed, are brightly colored, with a rose-red standard and white wings and keel, and are borne in large globose heads measuring up to 3–4 cm in diameter. Non-stoloniferous clovers with which this species may be confused include *Trifolium hybridum* L. (alsike clover) and *T. pratense* L. (red clover). The calyx teeth of buffalo clover are twice or more as long as the calyx tube, while those of alsike and red clovers are shorter than the tube. Flowers of buffalo clover are borne on long pedicels (4–12 mm), while red clover flowers are sessile. Buffalo clover might also be confused with the endangered running buffalo clover (*T. stoloniferum* Muhlenb. ex Eaton), a perennial, white-flowered, stoloniferous species, because of the size of the inflorescence of the latter. The growth habit and flower color distinguish the two species.

Historically, buffalo clover was known from much of eastern North America (northern Florida north to western New York and southern Ontario, and from the Atlantic coast west to eastern Nebraska, Kansas, Oklahoma, and Texas), and is presumed to have disappeared from Pennsylvania, West Virginia, Virginia, Maryland, New York, and Ontario (Campbell et al. 1988). It is considered endangered in Indiana (M. Homoya, pers. comm.) and Kentucky (Warren et al. 1986), and has been considered extirpated from Ohio (Roberts & Cooperrider 1982, Ohio Division of Natural Areas & Preserves 1988), since the last collection was made in 1955 . The species was rediscovered in 1990 in Pike County, Ohio, an unglaciated area of the state (Cusick & Silberhorn 1977). The historical and present distribution of *T. reflexum* in Ohio is shown in Figure 1.

Trifolium reflexum L. was first reported from Ohio by Riddell (1835), from Worthington (Franklin Co.). It has subsequently been reported in most floristic treatments covering Ohio plants, including Kellerman & Werner (1893), Schaffner (1928), and Weishaupt (1971). The species has apparently never been common in the state, since only 17 collections could

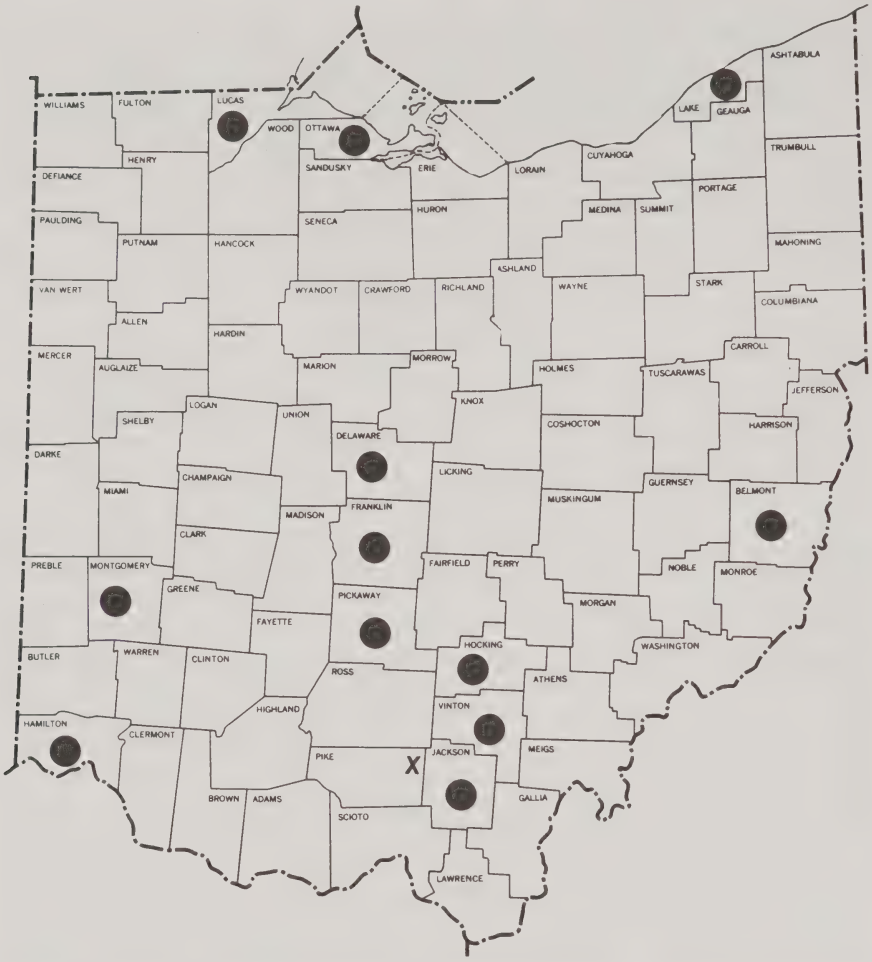

FIGURE 1. Map of Ohio counties for which *Trifolium reflexum* herbarium specimens could be located. Dots represent specimens from 1955 and earlier. The newly discovered population is represented by an X.

be documented from the 35 herbaria consulted (see list of specimens studied; herbarium abbreviations from Holmgren et al. 1990).

The newly discovered Ohio population of 25–30 plants is on an open to lightly wooded, south-facing, 60° slope, on sandy loam over Mississippian system sandstone (Cusick & Silberhorn 1977). The species occurs mainly in shallow, moist drainage troughs on the face of the ridge, which burned in the fall of 1989. The drainage troughs are wetter than the adjacent grassy portions of the slope (dominated by *Danthonia spicata* (L.) Beauv.), where no buffalo clover was observed. Many deer tracks were seen, and most plants had been grazed. Dominant woody associates are *Populus grandi-*

dentata Michaux root suckers, *Quercus stellata* Wangenh. and *Rubus allegheniensis* Porter. Other woody associates include *Crataegus* species, *Pinus virginiana* Miller seedlings, *Quercus prinus* L., *Q. velutina* Lam., *Rhus copallina* L., *R. radicans* L., *Rosa carolina* L., *Rubus occidentalis* L., *Rubus* sp. (*flagellaris* group), and *Smilax glauca* Walter. Dominant herbaceous associates include *Carex rugosperma* Mackenzie, *Panicum depauperatum* Muhlenb., *Phytolacca americana* L., and *Triodanis perfoliata* (L.) Nieuwl. Other herbaceous associates include *Carex glaucodea* Tuckerman, *C. pensylvanica* Lam., *Cunila origanoides* (L.) Britton, *Elymus* sp., *Eupatorium rotundifolium* L., *E. serotinum* Michaux, *Gnaphalium obtusifolium* L., *G. purpureum* L., *Galium aparine* L., *Hedeoma pulegioides* (L.) Pers., *Hypericum gentianoides* (L.) B.S.P., *Juncus* sp., *Porteranthus stipulatus* (Muhlenb. ex Willd.) Britton, and *Solanum nigrum* L.

Plants from Ohio have been called *T. reflexum* f. *glabrum* (Lojac.) Isely (Isely 1951) and *T. reflexum* var. *glabrum* Lojac. (Lojacono 1883) based on the degree of pubescence. In their monograph of the genus *Trifolium*, Zohary and Heller (1984) maintain the varietal name based on the degree of leaflet pubescence. After examination of numerous specimens from throughout the range of the species, I believe recognition of subspecific taxa in the species is unwarranted, as is indicated by Isely (1990). All young plants studied as herbarium specimens exhibited a modicum of pubescence which appears to be lost as plants mature. Very young plants examined were almost always moderately to densely hirsute, while mature plants varied from lightly hirsute to nearly glabrous. The only entirely glabrous plants observed were nearly senescent.

Buffalo clover may be more common than its collection history indicates, since the flowering period seems extremely short. It should be sought in those areas where it is considered rare or extirpated in lightly wooded areas, especially in those having undergone recent burns or other disturbances.

SPECIMENS EXAMINED

OHIO. BELMONT CO.: Captina Creek, 12 Jun 1913, *E.E. Laughlin s.n.* (OS). DELAWARE CO.: Red Hills near Harlem, 25 Jun 1927, *R.B. Gordon & F. Chapman s.n.* (OS). FRANKLIN CO.: Worthington, without date, but certainly before 1835, *J.L. Riddell s.n.* (MO). HAMILTON CO.: woods, 5 Jun 1838, *T.G. Lea s.n.* (PH); West Fork woods, 23 Jun 1910, *E.L. Braun s.n.* (US); College Hill, 1896, *W.H. Aiken s.n.* (OS). HOCKING CO.: Jun 1875, collector unknown (NY). JACKSON CO.: Liberty Twp., dry woods, 27 Sep 1936, *F. Bartley & L.L. Pontius s.n.* (OS). LAKE CO.: near Painesville, Jun 1887, *W.C. Werner 6147* (OS). LUCAS CO.: sandy meadow below Ironville, 25 May 1877, *J.A. Sanford 539* (OS). MONTGOMERY CO.: Dayton, Jun 1878, *H. Martin s.n.* (JHWU). PICKAWAY CO.: Washington Twp., 30 Jun 1929, *L.L. Pontius s.n.* (OS); Washington Twp., May 1932, *L.L. Pontius s.n.* (BHO); Washington Twp., Devil's Backbone, 15 Jun 1932, *F. Bartley s.n.* (BHO). OTTAWA CO.: Johnson Island in Sandusky Bay, 15 Jun 1895, *M. Matern s.n.* (BGSU). PIKE CO.: Jackson Twp. sect. 2, 1 Jun 1990, *M.A. Vincent, R.J. Hickey & A.M. Navaro 3665* (MU) and 19 Jun 1990, *M.A. Vincent, A.W. Cusick, J. Baird & L. Berry 3693* (MU). VINTON CO.: Vinton Furnace Experimental Forest, 21 Jun 1955, *G.W. Hall 1299* (BHO).

ACKNOWLEDGMENTS

I am grateful to the curators of the following herbaria, who searched their collections for Ohio specimens: Antioch College, Baldwin-Wallace College, BGSU, BHO, CINC, CLM, Cuyahoga Community College, DHL, DMNH, F, GH, Heidelberg College, ILL, IND, JHWU, KE, KY, Malone College, Marietta College, MICH, MO, MU, MUS, NY, OC, Ohio Northern University, OS, PH, University of Akron, University of Dayton, US, Walsh College, WIS, WSFA, and YUO. I also thank A.W. Cusick and M. Penskar for their helpful comments on the manuscript.

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NOTEWORTHY COLLECTIONS

OHIO

EPILOBIUM PARVIFLORUM Schreber (Onagraceae) Small-flowered Hairy Willow-herb

Previous knowledge. Brown (1879) reported this Eurasian species as scarce, meaning that "from two to four specimens were found," on ballast deposits dumped in New York City by ships arriving from Europe. In his revision of *Epilobium*, Trelease (1891) noted incidentally a specimen "collected on ballast at Hoboken, N. J."; and commented "but [it] does not belong to our flora." Because he gave a full entry to the related Eurasian species, *E. hirsutum* L., even though he thought it only "doubtfully established in this country," it is clear that he regarded the specimen of *E. parviflorum* as an adventive. The New Jersey record is the only report given by Gleason (1952). Nearly a century after Brown's first North American record, Purcell (1976) reported the species naturalized in several counties of Ontario, the earliest collection made in 1968. Data on two of the herbarium specimens, one reading "clay field" and the other "cedar-tamarack swamp," suggest calcareous habitats. Voss (1985) found specimens of *E. parviflorum* from six counties in the northern part of Michigan's Lower Peninsula, the first collection having been made in 1966. In 1990, Voss (*16109*, MICH) discovered the species in a seventh county, Charlevoix. This specimen and other Michigan collections were studied by B.K.A. in 1991. The study revealed that a few of the Michigan specimens were collected from fens and cedar swamps, and none from sites readily identifiable as non-calcareous.

Significance. This is the first report of *Epilobium parviflorum* from Ohio. The earliest collection was made in 1979.

Diagnostic characters. The descriptive statements here are based on the plants found in Ohio. *Epilobium parviflorum* is most easily confused with *E. hirsutum*. Both species attain heights of ca 1–1.5 m; both have stems with at least the upper internodes pubescent with long, soft, spreading hairs; both have softly pubescent leaves; and both have a 4-lobed stigma. They may be distinguished by two main features: in *E. parviflorum* the leaves are sessile but not clasping, and the petals are (4-) 6–7 (-9) mm long; in *E. hirsutum* the leaves are clasping, and the petals are 12–20 mm long.

Purcell (1976) noted that some Ontario specimens were misidentified as the native *E. strictum* Muhl. The stems and leaves of *E. parviflorum* are densely pubescent to villous with soft, flexuous, mostly spreading hairs ca 1 mm long, the leaves narrowly oblong to lanceolate, and 2.5–10 cm long and 7–30 mm wide; the flowers have pinkish-purple petals and a 4-lobed stigma. The stems and leaves of *E. strictum* are pubescent with stiff, straight, spreading hairs ca 0.3 mm long, the leaves narrowly lance-oblong to

broadly linear, and 2–5 cm long and 3–5 (-8) mm wide; the flowers have pink petals and an unlobed stigma.

OHIO. PORTAGE CO.: rare, moist cat-tail dominated swale, E of fen meadow, 0.1 km E of RR, 0.35 km N of St. Rte. 303, Streetsboro Twp., Hudson Quad., 15 Sep 1990, *Andreas & Cooperrider 6735* (KE). STARK CO.: frequent, marsh on S side of Mt. Pleasant Rd., E of Arlington Ave., NW 1/4 of Sec. 4, Jackson Twp., 6 Aug 1979, *Andreas 4515* (KE), and 2 Sep 1990, *Cooperrider & Andreas 12533* (KE, MO); wet calcareous ground at Jackson Bog State Nature Preserve, Sec. 20, Jackson Twp., 2 Sep 1990, *Cooperrider & Andreas 12534* (KE). SUMMIT CO.: frequent, wet ditch paralleling RR tracks, N of St. Rte. 619, W of Myersville Rd., S of sand and gravel operation, NE 1/4 of Green Twp., 25 Sep 1979, *Andreas 4867* (KE), and 2 Sep 1990, *Cooperrider & Andreas 12532* (KE, MO).

All four Ohio collection sites are calcareous seeps in the northeastern quarter of the state. At each site, *Epilobium parviflorum*, although not abundant, is well established in relatively undisturbed areas, blending in with the indigenous species as if it were a native.

ACKNOWLEDGMENTS

We thank James S. Pringle for calling our attention to the possible occurrence of this species in Ohio, Richard S. Mitchell for comments on the New York collection, Edward G. Voss for comments on the Michigan collections, Allison W. Cusick for helpful review suggestions, and Peter C. Hoch for verifying the identity of the two specimens sent to MO.

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BIOLOGICAL POLLUTION: THE CONTROL AND IMPACT OF INVASIVE EXOTIC SPECIES

The Indiana Academy of Science is organizing a major symposium entitled **Biological Pollution: The Control and Impact of Invasive Exotic Species.** It is scheduled for 25–26 October 1991 at the IUPUI University Place Conference Center in Indianapolis and will feature 26 outstanding invited speakers form across the country representing various federal, state, and private agencies. The presentations will focus on the impact of invasive exotics (animals and plants) on the native species and natural aquatic and terrestrial systems of eastern North America. Special consideration will be given to vectors, economic and environmental consequences, land management practices, prevention, interagency communication, control measures, and legislation. Attendance is limited to 350. For registration information contact:

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EDITOR'S NOTE
BOOK REVIEW EDITOR APPOINTED

We are happy to announce the appointment of a book review editor for *THE MICHIGAN BOTANIST*. Dr. Neil A. Harriman, a botanist at the University of Wisconsin-Oshkosh and a member of our Editorial Board, has agreed to handle this aspect of our operation. Neil will assign books that we receive to reviewers, remind delinquent reviewers of their agreement (like those noted in our Editorial Report [29:142].), and forward completed manuscripts to us for processing into the copy that our readers will see.

We thank Neil for consenting to help us. We have taken this action for the benefit of our readers—providing information on books of interest to Great Lakes botanists is something that we should do. It is our hope that more reviews will appear in forthcoming issues.

Neil can be reached at: Dr. Neil A. Harriman
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—Richard K. Rabeler & Gary L. Hannan

The January issue (Vol. 30, no. 1) was mailed August 15, 1991.

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On the cover: *Southwestern Chapter outing at Warren Woods. Photographed by Clayton Alway, Spring 1978.*

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THE MICHIGAN BOTANIST

May, 1991

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CONTRIBUTION TO THE VASCULAR (AND MOSS) FLORA OF THE GREAT PLAINS: A FLORISTIC SURVEY OF SIX COUNTIES IN WESTERN MINNESOTA[1]

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ABSTRACT

A survey of the vascular flora of six counties in western Minnesota was conducted during the 1987 and 1988 field seasons as part of the Minnesota County Biological Survey. These counties are geographically and floristically part of the Great Plains. The catalogue lists 980 vascular taxa from the six-county area, at least 22 of which were unreported from the Great Plains by the Great Plains Flora Association (differing taxonomic concepts account for the inclusion here of an additional 8 taxa not included by this authority in the flora of the Great Plains). One of the previously unreported species, *Carex abdita*, was recorded from five of the six counties surveyed, where it grows primarily, and sometimes abundantly, in sandy prairie. *Eragrostis minor* and *Fimbristylis puberula* var. *interior* are reported new to Minnesota and a second station is recorded for *Carex xerantica*. New sites were discovered for the rarities *Agalinis auriculata, Cyperus acuminatus,* and *Desmanthus illinoensis,* species which had not been collected in the state for over 25 years. The survey increased from 42 to 47 the number of taxa known to occur in the six-county area that are officially listed by the State as Endangered, Threatened, or Special Concern, or are proposed for listing. Comments on the ecology of some notable vascular plants are also made here. Lastly, incidental collection of mosses during the survey recorded 19 taxa previously unreported from the study area, thus increasing to 96 the number of moss taxa known from western Minnesota.

INTRODUCTION

The Great Plains, which comprises about a fifth of the land area of the contiguous United States (Great Plains Flora Association [GPFA] 1986), is a relatively young floristic region encompassing a diversity of vegetation types, with mixed grass prairie and shortgrass steppe predominating (Küchler 1964). While the vascular flora (GPFA 1986), and to a lesser extent the bryophyte flora (Churchill 1976, 1977), of the Great Plains are reasonably well known, new plant records continue to be reported from individual states within this region (e.g., Ownbey & Smith 1988).

Thirty-seven counties in western Minnesota lie totally or partly within

[1]Biological Report No. 35, Minnesota Natural Heritage and Nongame Wildlife Programs, Department of Natural Resources, St. Paul, Minnesota.
[2]Requests for reprints should be forwarded to this address.

the geographically and floristically coherent Great Plains (GPFA 1977, 1986). A comprehensive survey of the vascular flora of six of these, Big Stone, Clay, Lac Qui Parle, Norman, Traverse, and Wilkin (Fig. 1), was conducted during the 1987 and 1988 field seasons in the first phase of the Minnesota County Biological Survey (MCBS). The MCBS, a project of the Natural Heritage and Nongame Wildlife Programs of the Minnesota Department of Natural Resources, is a systematic, county-by-county survey of natural communities, and of plant and animal species that are rare in the state. These six counties were selected to begin the Survey because of the relatively large amount of native prairie surviving there compared with other parts of the state that were originally prairie. The plant survey was conducted primarily by the authors, with other MCBS staff contributing.

This paper is intended primarily as a supplement to (1) the "Flora of the Great Plains" (GPFA 1986) and (2) the "Mosses of the Great Plains" (Churchill 1976), and more specifically for that portion of the Great Plains that occurs in Minnesota. Here we document the vascular and moss floras of six counties in western Minnesota, based on specimens at the University of Minnesota Herbarium, including the new material collected in this survey. We also discuss some of the more ecologically significant observations made during the field work. The information presented here should be useful for future work in western Minnesota and adjacent states.

STUDY AREA

Physiography and drainage. Physiographic diversity within the study area (approximately 11830 km^2) is moderate, ranging from level glacial lake plain to steeply rolling moraine, with the deep valley of Glacial River Warren—containing Lake Traverse, Big Stone Lake, and the extant Minnesota River—providing the greatest local relief (Fig. 2). The Glacial Lake Agassiz basin is a nearly featureless plain except in the interbeach zone on the east side where fluctuating lake levels left a series of narrow beach ridges and wavecut scarps superimposed upon the gradual rise to the upland margin. The nearly level bed of Glacial Lake Benson southeast of Ortonville is bisected by the Minnesota River Valley, a several-kilometer-wide band of abandoned channels and terraces of Glacial River Warren in which the Minnesota River lies 25 meters below the lake plain. Just below Ortonville the valley is dotted with water-scoured exposures of granite bedrock, some of which were islands in the glacial river (Matsch & Wright 1967; Fig. 3). This is the only bedrock exposed in the study area. Gently rolling ground moraine dominates the uplands, and there is a smaller area of stagnation moraine characterized by more steeply rolling relief, sometimes exceeding 30 meters, and an abundance of kettle ponds and lakes. A narrow zone of rugged topography occurs along the steep-sided River Warren trench between Wheaton and Ortonville, where numerous draws and deep, short coulees indent the 30–50 meter-high bluffs

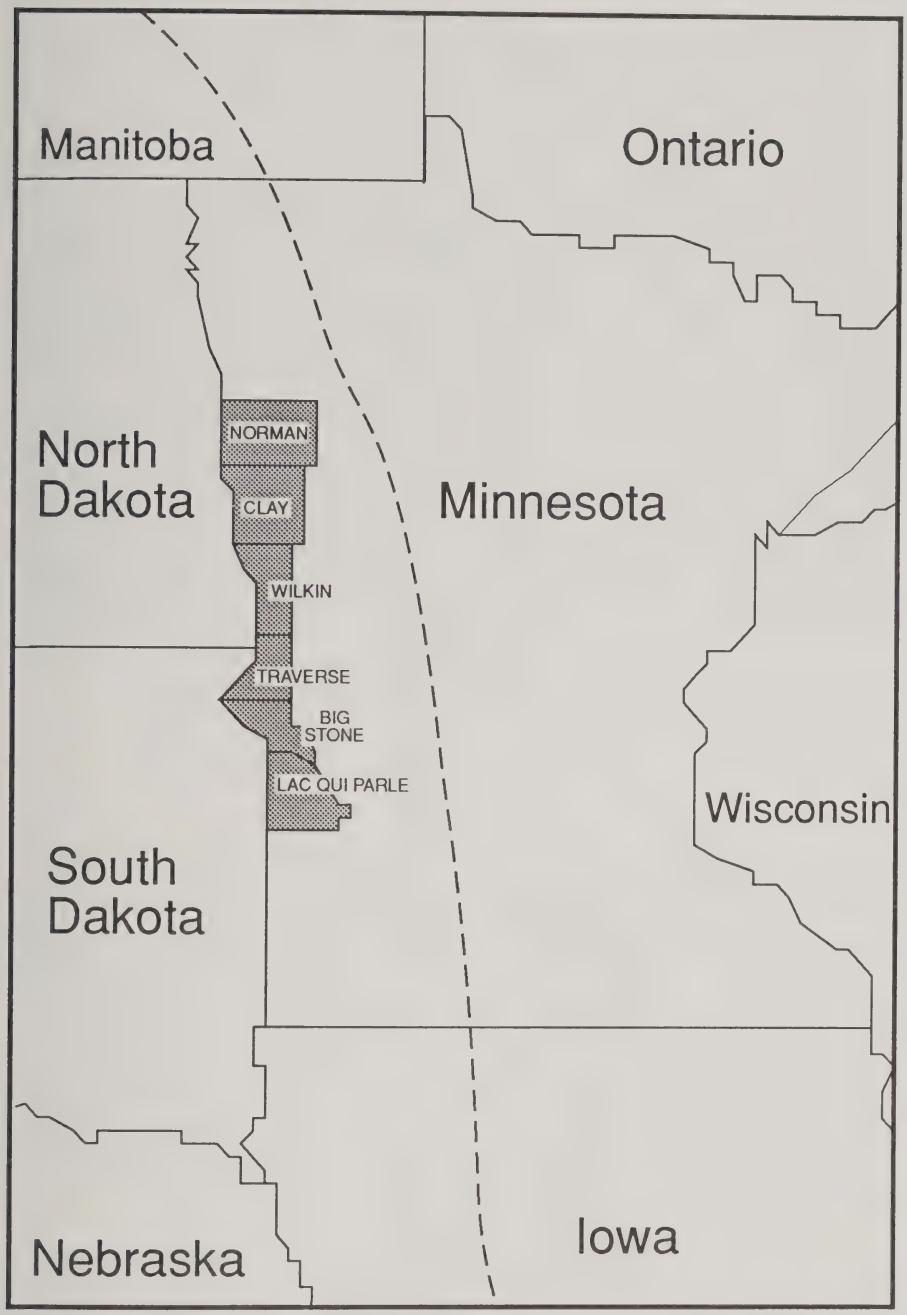

FIGURE 1. Map of six-county study area (shaded). Dashed line is eastern boundary of the Great Plains, as shown in Great Plains Flora Association (1977).

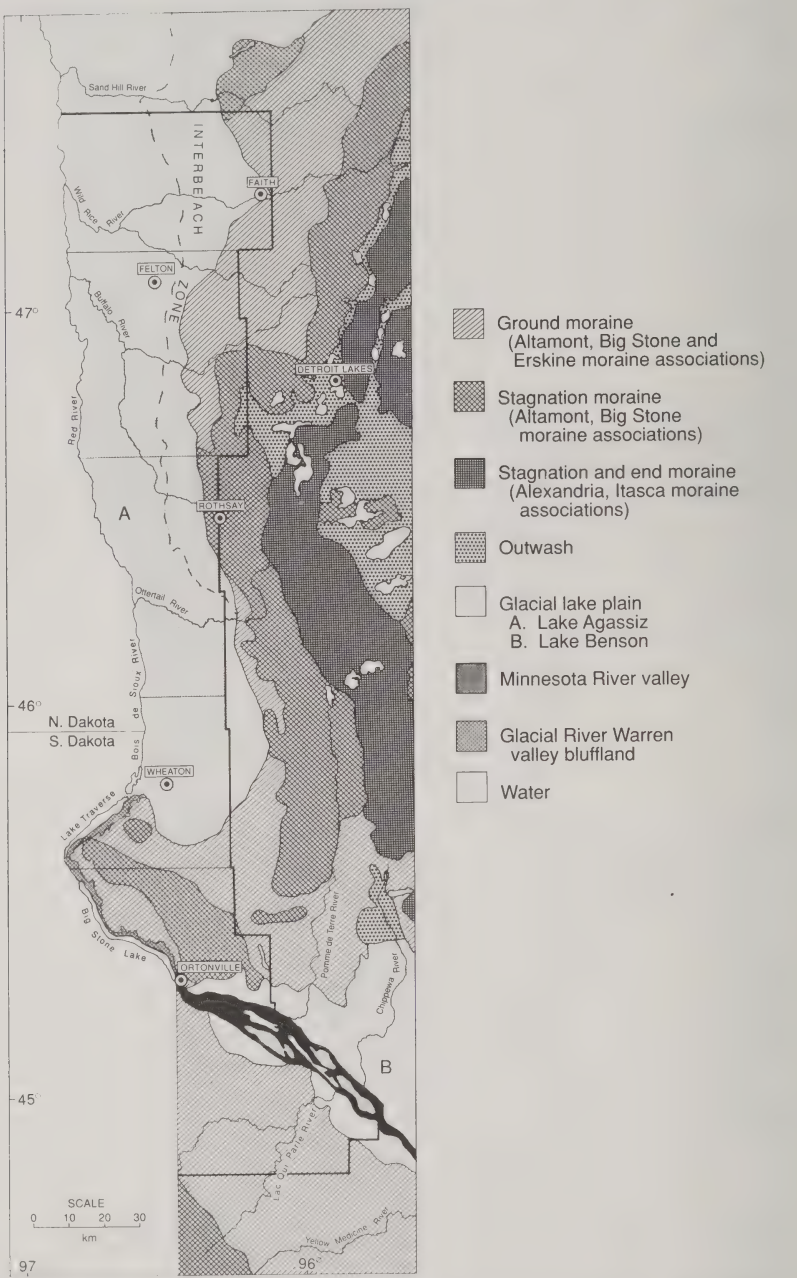

FIGURE 2. Surficial geology of the study area region of western Minnesota. Adapted from Hobbs and Goebel (1982) and University of Minnesota (1969, 1979, 1980). Towns mentioned in the text are also mapped.

FIGURE 3. Granite outcrop in the Minnesota River Valley below Ortonville. This valley was scoured by Glacial River Warren, which gave these outcrops their characteristic rounded forms. Surrounding vegetation here is wet and mesic prairie, somewhat degraded by past livestock grazing. Quarrying operations are destroying the largest outcrops. Plover Prairie Preserve, 7 July 1990.

above the lakes (Cover photo[3] and Fig. 4). Elevations range from 250 meters above sea level in the lake plain at the north end of the area to 466 meters on hilly stagnation moraine in southeastern Clay County. Most of the Agassiz basin lies between 260 and 320 meters, and most of the morainic uplands are between 320 and 380 meters.

The study area is divided between two major drainage systems: the Bois de Sioux and Red rivers, draining north to Hudson Bay, and the Minnesota River, draining southeast into the Mississippi. Larger tributaries of the Red River are the Buffalo, Marsh, Ottertail, and Wild Rice rivers, which originate in the uplands and flow west and north across the lake plain as winding, sluggish streams. The Lac Qui Parle River, which drains most of the study area south of the Minnesota River, is the only major tributary of the

[3]Cover photograph. View from Traverse County west across the steep-sided valley of Glacial River Warren, the southern outlet of Glacial Lake Agassiz. Lake Traverse is in the bottom of the valley. Dry prairie clothes the steeper slopes, with woodland dominated by *Quercus macrocarpa* and *Fraxinus pennsylvanica* on footslopes and in draws. Opposite bluffs are in South Dakota. Bonanza Prairie Scientific and Natural Area, 14 August 1983. Photo by Keith Wendt. (Unless otherwise noted, all photos are by the authors.)

FIGURE 4. View north down one of the large coulees tributary to the Glacial River Warren trench through the Big Stone moraine. Dry-mesic and dry prairie dominate the slopes, with thickets and young, postsettlement woodland of *Quercus macrocarpa* and *Fraxinus pennsylvanica* along the bottom and in hollows. Note the greater amount of woodland on the east-facing (left) slopes. The surrounding uplands are cultivated. 28 June 1988.

latter within the area. In the uplands, streams are small and widely spaced, and closed depressions of various sizes are abundant. Drainage in the Glacial Lake Agassiz lake plain has been greatly facilitated by an extensive network of manmade ditches.

Soils

Calcareous glacial drift of Late Wisconsin age is the parent material of all soils in the study area. The uplands are till with local areas of outwash. Lacustrine silts and clays predominate in the deeper, north part of the Agassiz basin, whereas water-modified till predominates in the south part. Sandier sediments are common toward the basin margin. Old beach ridges of gravelly, coarse sand are a prominent feature of the interbeach zone, and a complex of dune blankets formed in lake-margin deltaic sands occurs in northern Norman County and adjacent Polk County. Silts and fine sands cover the lake-plain wedge southeast of Ortonville (Hobbs & Goebel 1982). The predominant soils are Calciaquolls, Haplaquolls, and Haploborolls, but Haplustolls are common south of the Minnesota River, and Eutroboralfs occur locally in the uplands along the northeast side of the area

(Cummins & Grigal 1981). Saline conditions are occasional, primarily in the Glacial Lake Agassiz basin.

Climate

The area has a continental climate of the cool, subhumid temperate type, characterized by short, warm summers and long, cold winters. Annual average temperature ranges from 7 degrees (all temperatures Celsius) in the south part of the study area to about 4 degrees in the northeast (the Agassiz basin is warmer and drier than the uplands to the east). January is the coldest month, with an average temperature of -13 to -17 degrees south to north, and an average minimum of -18 to -23 degrees. The average for July, the warmest month, is 23 to 21 degrees south to north, and the average maximum 29 to 27 degrees (Baker et al. 1985). Annual precipitation is less than 58 cm over most of the area, ranging from 51 cm on the west edge in the Red River Valley to 66 cm south of the Minnesota River. About 70 percent of the precipitation occurs between May and September, with June the wettest month (Baker & Kuehnast 1978). Pan evaporation for the period 21 April to 10 October averages 112 cm in the south to 102 cm in the north (Baker et al. 1979). Mean annual snowfall is about 76 cm (Kuehnast 1972), and snow depth of 2.5 cm or greater is recorded on average 100 days in the south to 115 in the northeast (Kuehnast et al. 1982).

Vegetation

The study area lies within a narrow zone of tall grass prairie (bluestem prairie of Küchler [1964]) on the eastern margin of the northern Great Plains. The prairie-forest transition is just east of the study area (Fig. 5), whereas the eastern limit of the transition grassland zone (wheatgrass-bluestem-needlegrass of Küchler [1964]) of the northern mixed grass prairie is less than 50 km to the west, at the west margin of the Glacial Lake Agassiz basin (Barker & Whitman 1988). At the time of the Public Land Survey (1850–1870), the study area was almost entirely covered by prairie and prairie wetland, with some outliers of transition woodlands occurring northward along the east margin (Fig. 5). These were primarily bur oak openings and aspen-oak woodlands, but small areas of richer woods with sugar maple were also present. Woodland narrowly bordered most major streams, and oak openings occurred on the dissected bluffs above Big Stone Lake and Lake Traverse (Fig. 5).

Today, agriculture dominates the area. Only vestiges of prairie remain in the gently rolling uplands or in the Agassiz lake plain exclusive of the interbeach zone. Grassland vegetation is most commonly dominated by *Bromus inermis, Poa pratensis*, and other exotic and native weedy species. Prairie vegetation survives primarily on steep slopes, poorly drained sites, or where soils are droughty and infertile, and has been modified to varying degrees by grazing, attempts at cultivation, and absence of fire.

Typical mesic tall grass prairie dominated by *Andropogon gerardii,*

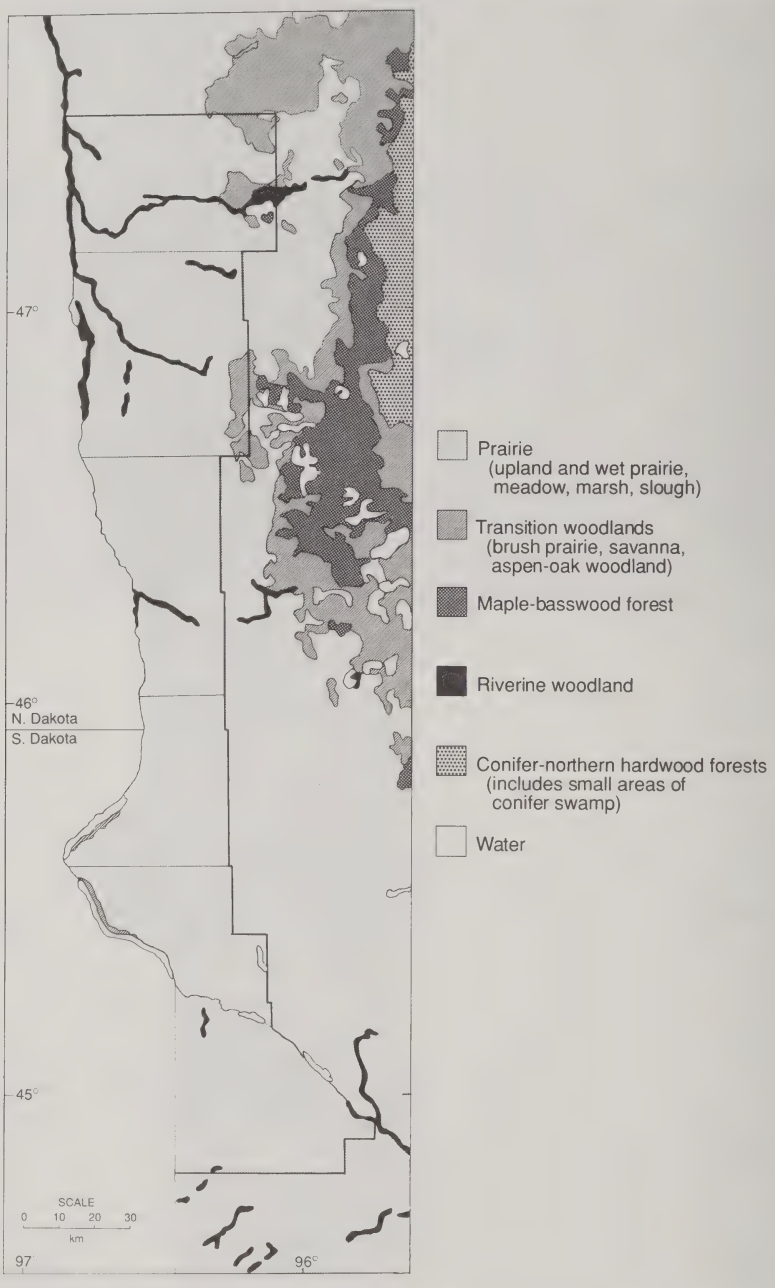

FIGURE 5. Vegetation of the study area region of western Minnesota at the time of the Public Land Survey (1850–1870). Adapted from Marschner (1974). The portion of the Dakotas included in the figure was tallgrass prairie except for woodland along larger streams and local occurrences of brush prairie or savanna associated with steeper topography (Küchler 1964).

FIGURE 6. Late spring view of flat prairie in the southern end of the Glacial Lake Agassiz basin. Mesic prairie dominated by *Andropogon gerardii* and *Sorghastrum nutans* occupies the foreground, but most of this tract supports wet prairie. The band of darker, taller grass extending from the lower right towards the figure is a segment of a large "fairy ring", a zone of nitrogen enrichment produced by a fleshy fungus. The prominent inflorescenses are *Senecio plattensis*. This prairie is mowed annually for hay. Miller Prairie West, 4 June 1978.

Sorghastrum nutans, and *Sporobolus heterolepis* usually occurs as a lesser component of predominantly wet or dry prairie remnants (Fig. 6), but a few larger tracts of this type of prairie exist (Fig. 7). Wet prairie is more common, and there are a number of large tracts northward in the very low-relief interbeach expanses. Dominants of wet prairie in this area are typically *Andropogon gerardii, Calamagrostis inexpansa*, and *Spartina pectinata*, and *Muhlenbergia richardsonis* is abundant in the understory. Sedges are usually an important component, most commonly *Carex lanuginosa, C. praegracilis, C. sartwellii,* and *C. tetanica. Calamagrostis canadensis*, a major component of wet prairie eastward (Curtis 1959), is generally uncommon because of higher soil salinities (Stewart & Kantrud 1972). Local areas of higher salinity that are vegetationally similar to "saline meadow" types described by Redmann (1972) from eastern North Dakota occur in many wet prairies, especially in the Agassiz basin. The shallow saline lake or alkali pond wetland type that is frequent in the Dakotas and the prairie region of Canada (Stewart & Kantrud 1972, Adams 1988) has a single representative within the study area (Fig. 8). Calcareous fens on marly sedge peat occur where there is a constant and copious discharge of calcium-enriched groundwater (Fig. 9).

FIGURE 7. Early summer aspect of mesic prairie on undulating ground moraine in Big Stone County. Drier swell in the foreground is dominated by *Andropogon gerardii, Bouteloua curtipendula,* and *Stipa spartea. Echinacea angustifolia* inflorescences and the pale foliage of *Amorpha canescens* are conspicuous. A narrow swale runs across the background; the darker band is a dense growth of annual *Polygonum* and *Rumex* species on mud exposed by drought. Clinton Prairie Scientific and Natural Area, 27 June 1988.

Most fens in the study area are on the downslope (west-facing) sides of old beach ridges, but several occur in the moraine to the east. These fens harbor a number of interesting eastern and northern species.

Dry prairies on steep slopes in finer textured soils are usually dominated by *Bouteloua curtipendula, Schizachyrium scoparium, Sporobolus heterolepis,* and *Stipa spartea*, with variable amounts of *Andropogon gerardii* and *Sorghastrum nutans* (Fig. 10). The most xeric prairies, on gravelly, coarse textured soils of larger beach ridges and steeply sloping ice-contact deposits (Fig. 11), have a strong affinity with mixed grass prairie, closely resembling the "high prairie" type described by Dix & Smeins (1967) from the transition grassland region of North Dakota. Major species of the driest areas include, among others, *Bouteloua gracilis, Calamovilfa longifolia, Carex eleocharis, Koeleria macrantha, Schizachyrium scoparium,* and *Stipa comata*. Dune areas support a savanna of stunted *Quercus macrocarpa* in another dry prairie type (Fig. 12). This prairie has many species in common with gravel prairies, but a number of arenicolous species are distinctive, such as *Carex foenea, Cyperus schweinitzii,* and *Petalostemon villosum*. The dune vegetation is quite similar to that reported for North Dakota sandhills (Whitman

FIGURE 8. Shallow marsh zone on the margin of a saline lake in Lac Qui Parle County, dominated by *Distichlis stricta*, with *Salicornia rubra* (low plants on open mud near center of photo). This zone is inundated through early summer of most years. Salt Lake Wildlife Management Area, August 1979. Photo by Welby Smith.

& Wali 1975), except that *Andropogon hallii* is not present in Minnesota. *Populus tremuloides* and *Fraxinus pennsylvanica* have invaded Minnesota dunes with postsettlement fire suppression and livestock disturbance. The granite outcrops in the Minnesota River Valley provide yet another xeric habitat, but one that is somewhat fire-protected and so harbors several species of very limited distribution in the state in addition to common dry-prairie plants (Fig. 13).

Native woodland is common in the interbeach zone and on the uplands east of the Glacial Lake Agassiz basin, as well as along Lake Traverse and Big Stone Lake and in the Minnesota River Valley. Most of this woodland has developed since settlement from brush prairie and oak openings and is characterized by a very depauperate flora. Woods dominated by *Populus tremuloides,* with some *P. balsamifera*, are frequent on wet to mesic sites in the north part of the study area, and groves of these trees are a common feature of interbeach-zone prairies today (Fig. 14). The most important trees of upland woods are *Fraxinus pennsylvanica, Quercus macrocarpa,* and, northwards, *Populus tremuloides,* with *Acer negundo, Tilia ameri-*

FIGURE 9. Calcareous seepage fen in Norman County near the town of Faith. The tussocks are principally *Muhlenburgia glomerata* and *M. richardsonis*, with *Carex sterilis* and *Scirpus cespitosus*, and small *Betula glandulifera* shrubs are scattered throughout. Flowers of *Parnassia palustris* and occasional wands of *Solidago nemoralis* are conspicuous. The cow is mired in the oozy peat between hummocks, giving a misleading impression of the height of the vegetation. This fen lacks the nonhummocky habitat with *Cladium mariscoides* that is present in another fen about 2.5 km to the southwest in the same wetland complex (see text). Faith Fen, 23 August 1985.

cana, and *Ulmus americana* less common. Woodland of this type occupies mesic to dry-mesic sites in the rugged topography along Big Stone Lake and Lake Traverse (Cover photo and Figs. 5, 10) and in more steeply rolling moraine. Stands of more diverse forest occur on the hilly uplands in extreme eastern Clay and Norman counties as remnants of presettlement forest outliers. *Acer saccharum, Fraxinus nigra*, and *Quercus rubra*, among others, are limited to these stands. Riparian woodlands, which are generally little more than narrow strips between cropland and stream, are dominated by the common trees of upland woodland along with *Populus deltoides* and *Salix amygdaloides*. American elm has been ravaged by Dutch elm disease, and few large trees survive. Finally, small, planted woodlots and windbreaks of boxelder, cottonwood, green ash, and *Ulmus pumila* are common throughout the study area.

FIGURE 10. Dry-mesic prairie on bluffs bordering Big Stone Lake in the Glacial River Warren trench. Fruiting culms of *Stipa spartea* are conspicuous in this early summer view; other major grasses here are *Bouteloua curtipendula, Schizachyrium scoparium,* and *Sporobolus heterolepis*, all of which fruit later in the season. Woodland dominated by *Quercus macrocarpa* in deeper draws has grown up from brushy thickets with the postsettlement reduction in fire frequency. Bonanza Prairie Scientific and Natural Area, 7 July 1990.

FIGURE 11. Dry gravel prairie on a kame in Lac Qui Parle County. The pale, empty fruiting culms of *Stipa comata* and *S. spartea* are clearly visible in this midsummer view. *Amorpha canescens* and *Ratibida columnifera* are also conspicuous. A small pothole lake lies beyond the hill. Yellow Bank Hills Scientific and Natural Area, July 1987. Photo by R. Djupstrom.

FLORA

The catalogue of vascular plants given at the end of this report lists 980 taxa (905 species and 75 infraspecific taxa and hybrids) in 411 genera from 111 families for the six-county area. A total of 1082 new county records were made during the two field seasons, including records for 67 taxa previously unknown from the six-county area (Ownbey & Morley 1991). Two taxa, *Eragrostis minor* and *Fimbristylis puberula* var. *interior*, are here reported for the first time from Minnesota. Significantly, 30 taxa listed in the catalogue are not treated in the *Flora of the Great Plains* (GPFA 1986). Of these, 11 are new reports from the six-county area (Table 1, Group A), 11 have been reported earlier from the study area (Table 1, Groups B and C); and 8, marked in the catalogue with a superscript, are accounted for by differences in taxonomic concepts (here we follow Ownbey and Morley for consistency). Of the 22 taxa in the first two categories, *Botrychium campestre, Carex abdita,* and *C. conoidea* occur in prairies, whereas the remaining taxa are either forest species or plants that seem to require special edaphic conditions that are uncommon or rare in the Great Plains.

There are 42 taxa in the catalogue that are legally designated in Minne-

FIGURE 12. Dune land formed in deltaic sand deposits on the margin of Glacial Lake Agassiz. Sparsely vegetated dune slopes provide habitat for *Shinnersoseris rostrata* and *Oryzopsis hymenoides*. Pale tufts are *Artemisia frigida,* and a few flowering clumps of *Petalostemon villosum* are visible. Savanna of stunted *Quercus macrocarpa* is characteristic of dune land in this region. This photo was taken in Polk County, just beyond the Norman County line, but similar habitat extends into Norman County. Agassiz Dunes, 22 July 1986.

sota as State Endangered, Threatened, or Special Concern, and 5 that are proposed for designation (Smith 1988). Of the 47 taxa, five were previously unrecorded from the study area (Ownbey & Morley 1991). These are: *Cladium mariscoides, Eleocharis rostellata, Agalinis auriculata, Carex xerantica,* and *Cyperus acuminatus*. For the last three of these, the new records are the first from the state in over 25 years. Another state-listed species, *Desmanthus illinoensis,* although previously recorded from the study area, was also collected in Minnesota for the first time in over 25 years. Altogether, slightly over 540 records (including sight records) now exist for state-listed taxa in the six-county area, 260 of which were made during this study. In addition, two state rarities tracked by the state Natural Heritage Program but that have not been proposed for listing were newly recorded for the study area: *Carex capillaris* var. *major* and *C. conoidea*.

Approximately 49 percent of the species of vascular plants composing Minnesota's flora occur in the six counties surveyed. The Asteraceae (131 taxa), Poaceae (123 taxa), Cyperaceae (109 taxa), Fabaceae (41 taxa), and Rosaceae (37 taxa) have the largest representation, together accounting for 45 percent of the taxa recorded from the six-county area. The Asteraceae

FIGURE 13. Closer view of a granite outcrop in the Minnesota River Valley below Ortonville. Crevices in the rock provide a fire-protected, xeric habitat where cactus species can thrive. The cactus *Coryphantha vivipera* (next to pencil in foreground just right of center) is restricted in Minnesota to the Ortonville outcrops. The conspicuous flowering clumps are *Heterotheca villosa*. Heavy grazing has converted the surrounding prairie at this site to a typical pasture community dominated by exotic grasses, *Solidago* species, and *Symphoricarpos occidentalis*. 25 September 1988.

and Poaceae are represented by 52 and 53 genera, respectively, and the largest genus is *Carex* with 69 taxa. Some of the taxa listed in the catalogue reach the easternmost (e.g., *Carex hallii*) or westernmost (e.g., *C. tuckermanii*) limits of their ranges in western Minnesota, and some of them have one or more outermost stations within the study area. See Wheeler et al. (in press) for a list of taxa that reach the easternmost limits of their ranges in the state and, also, for a discussion and maps of a major floristic boundary in Minnesota, the western portion of which traverses the northern part of the study area.

Mosses were collected at only a few scattered localities within the study area. Of the 77 mosses listed from western Minnesota by Churchill (1976; see the Catalogue of Mosses at the end of this report), 41 were recorded during this survey. In addition, 19 mosses previously unreported from western Minnesota were discovered in the six-county area, although all of them have been reported from elsewhere in the Great Plains (Churchill 1976).

A complete set of the authors' voucher specimens for the vascular plants and mosses will eventually be housed at the University of Minnesota Her-

FIGURE 14. Wet prairie in the interbeach zone of the Glacial Lake Agassiz basin in Norman County, with typical postsettlement invasion of *Populus tremuloides* (woodland in distance). Prairie dominants include *Calamagrostis inexpansa, Spartina pectinata*, and several *Carex* species. Low shrubs in the middle distance and along the woodland margin are primarily *Salix* species, with some *Betula glandulifera*. Agassiz-Nelson Wildlife Management Area, 4 June 1990.

barium (MIN). One of us (GAW) takes full responsibility for the identification of specimens. Specimens other than those of the authors' that are mentioned in this paper are also currently (or eventually will be) preserved at MIN. We believe that the list is a nearly complete account of the native vascular flora of the six-county area, with the possible exception of the submerged aquatic plants. However, the list of non-native taxa for the six counties probably is not exhaustive. The list of mosses for the six-county area is also certainly incomplete.

COMMENTS ON NOTABLE TAXA

Below we discuss in varying degree of detail four groups of taxa, including all taxa in Group A and some of those in Group B of Table 1. In addition, we discuss some other notable taxa that occur in the study area, most of which have been mentioned previously. For convenience, the taxa are alphabetically arranged within groups. Citation of specimens is given at the end of the comments for each taxon.

TABLE 1. Twenty-two vascular taxa occurring in the six-county study area that are not treated in the *Flora of the Great Plains* (GPFA 1986). Group A: Taxa collected during the 1987–1988 survey that were previously unreported from the six-county study area. Group B: Taxa collected during this survey but reported earlier for the six-county study area by Ownbey and Morley (1991); additional reports of these taxa from the study area are also noted. Group C: Taxa reported for the six-county study area by Ownbey and Morley (1991) but not observed during this survey.

GROUP A
Agalinis auriculata
Agalinis paupercula
Carex abdita
Carex conoidea
Carex gracillima
Carex tuckermanii
Cladium mariscoides
Cornus rugosa
Osmunda cinnamomea
Streptopus roseus
Trientalis borealis

GROUP B
Botrychium campestre (Smith 1988; Wagner & Wagner 1986)
Cornus alternifolia
Hepatica americana
Juncus brevicaudatus
Primula mistassinica
Scirpus cespitosus var. *callosus*
Scleria verticillata (Smith 1983, 1988)
Tofieldia glutinosa (Smith 1988)
Viola conspersa

GROUP C
Mertensia paniculata
Oenothera perennis

GROUP I: Taxa newly recorded from the study area not treated in the "Flora of the Great Plains" (GPFA 1986) (Group A of Table 1).

Agalinis auriculata (Eared Gerardia) is rare throughout its range, and it is a category 2 species for possible Federal listing as threatened or endangered (U.S. Dept. of Interior, Fish and Wildlife Service 1985). Prior to this survey it was recorded in Minnesota only from three "wet meadow" sites in the lower Minnesota River Valley (Smith 1988). The new collection in Big Stone County extends the known range into the upper Minnesota River Valley. We discovered the plant in a shallow drainageway winding southeast through a degraded prairie pasture into the river valley. Typical grasses of the upland areas are *Andropogon gerardii, Bouteloua curtipendula, Poa pratensis, Schizachyrium scoparium, Sporobolus asper,* and *Stipa spartea. Calamagrostis inexpansa, Leersia oryzoides,* and *Muhlenbergia richardsonis* are more abundant in the wet prairie adjacent to the drainageway.

BIG STONE CO.: NW 1/4, NW 1/4, Sec. 35, T121N, R45W, 1.5 mi E of Odessa, wet meadow bordering drainageway of Minnesota River, 12 Aug 1985, *Converse s.n.*.

Agalinis paupercula (Small-flowered Gerardia) was reported by Holmgren (1986) as "Approaching the region [i.e., the Great Plains] in Minnesota", but it was not considered by him to actually occur in the Great Plains. We discovered two sites for this species in the study area, one in Norman County and the other in Wilkin. At both sites it grows in a calcareous fen, with the two fens having many taxa in common (also see discussions of *Cladium mariscoides* and *Fimbristylis puberula* var. *interior* below).

NORMAN CO.: SW 1/4, NW 1/4, Sec. 35, T144N, R43W, 7 mi ESE of Twin Valley, 0.6 mi W of Rte. 40, calcareous fen, 18 Aug 1988, *Wheeler 11876*. WILKIN CO.: SW 1/4, NW 1/4, SE 1/4, Sec. 33, T136N, R45W, 6.1 mi NW of Rothsay, 0.1 mi SW of Rte. 52, calcareous fen, 7 Aug 1987, *Dana 87108*.

Carex abdita (= *C. umbellata* Schkuhr ex Willd. sensu Mackenzie 1935) was not reported from the Great Plains by Kolstad (1986), although a closely related species, *C. microrhyncha* Mackenzie (a name synonymized under *C. abdita* by Steyermark 1963), was reported from Kansas and Missouri south to Texas. *Carex abdita* is well known from the eastern half of Minnesota, where it grows on rocky slopes, in thin soil around rock outcrops, and on cliffs and bluffs (Wheeler & Ownbey 1984). In contrast, it was recorded from only two sites in western Minnesota prior to this survey, one in Polk County and the other in Swift County, and very little was known about its ecology at the western sites. We observed this sedge in the northern five of the six counties surveyed (Fig. 1), where it grows in flat, sandy prairies and, more rarely, on river and lake bluffs. Such widespread occurrence in the study area was unexpected, as no previous worker studying prairies in western Minnesota or elsewhere in the Great Plains has reported *C. abdita* as an element of prairies of any type. This survey demonstrates that at some favored localities in western Minnesota this species is an important constituent of the ground cover in sandy prairie, although at most sites the plants are only locally abundant. Typical species in these prairies are *Amorpha canescens, Comandra umbellata, Liatris punctata, Muhlenbergia cuspidata, Pedicularis canadensis, Rosa arkansana, Schizachyrium scoparium, Solidago rigida,* and *Sporobolus asper*. In flat prairies this sedge grows in dense clumps that may extend several centimeters across and its leaves reach 30 cm long. By contrast, plants growing on river and lake bluffs generally form small clumps and the leaves are usually shorter than 10 cm.

Carex abdita is an early-flowering species, and its fruits (i.e., the perigynia), the majority of which are buried among leaves at the base of the plant, are shed relatively early in the year. The combined factors of early flowering, partially concealed fruits, and scarcity may explain, at least in part, why this species has been overlooked as an element of sandy prairie in western Minnesota in the past.

BIG STONE CO.: NW 1/4, SW 1/4, NE 1/4, Sec. 12, T121N, R46W, 2.5 mi ENE of Ortonville, 0.2 mi S of Rte. 64, sandy soil, 11 Sep 1988, *Wheeler 12209*. CLAY CO.: N 1/2, NE 1/4, SW 1/4, Sec. 30, T142N, R44W, 3 mi W of Ulen, 0.3 mi E of Rte. 111, sandy prairie, 7 Jun 1988, *Wheeler 10682*. NORMAN CO.: N 1/2, SW 1/4, Sec. 26, T144N, R44W, 1 mi E of Twin Valley, steep bluff bordering N bank of Wild Rice River, 24 May 1988, *Wheeler 10444*; N 1/2, SE 1/4, Sec. 17, T146N, R44W, 6 mi NNW of Gary on Rte. 32, sandy prairie, 3 Jun 1988, *Wheeler 10629*. TRAVERSE CO.: SW 1/4, SE 1/4, SE 1/4, Sec. 32, T125N, R46W, 17 mi E of Browns Valley, less than 0.1 mi N of Rte. 2, wet-mesic prairie strip between two kettle ponds, 19 Jul 1988, *Wheeler 11231*. WILKIN CO.: NE 1/4, NE 1/4, Sec. 5, T135N, R45W, 5.5 mi NW of Rothsay, Rothsay WMA, sandy prairie, 24 Jun 1988, *Wheeler 10838*.

Carex conoidea is known from a few scattered sites in Minnesota, where it grows in moist to wet meadows, low prairies and, more rarely, in open woodlands (Wheeler & Ownbey 1984). We discovered two sites for this species in Norman County. At the more northern site it is infrequent in low prairie, growing with *Agalinis tenuifolia, Hypericum majus, Juncus longistylis, J. nodosus, Lysimachia quadriflora, Pedicularis lanceolata, Polygonum punctatum,* and the rarity *Carex scirpiformis*. At the more meadow-like southern site, *Carex conoidea* is also infrequent, growing with species such as *C. tetanica, Fragaria virginiana, Luzula multiflora,* and *Potentilla anserina*.

NORMAN CO.: S 1/2, SW 1/4, SW 1/4, Sec. 25, T146N, R45W, 12 mi NE of Ada, moist meadow, 2 Jun 1988, *Wheeler 10597*; S 1/2, SE 1/4, Sec. 17, T146N, R44W, 6 mi N of Gary on Rte. 32, low prairie, 10 Aug 1988, *Wheeler 11605*.

Carex gracillima (Graceful Sedge) occurs throughout the forested region of Minnesota. It is best known from the northern half of the state, where it grows in deciduous and mixed conifer-hardwood forests and, less frequently, in wooded swamps and moist meadows (Wheeler & Ownbey 1984). We observed it in several mesic and wet woodland sites in eastern Norman County. In mesic woodland it grows with, among other species, *Aralia nudicaulis, Botrychium virginianum, Carex blanda, C. deweyana, C. pedunculata, C. rosea, Oryzopsis asperifolia, Sanguinaria canadensis, Schizachne purpurascens, Smilax lasioneura,* and *Uvularia grandiflora*. Typical mosses are *Anomodon minor, Entodon cladorrhizans,* and *Mnium cuspidatum*. At one site (mesic woodland) it occurs with *Acer saccharum*, a tree species known in the study area only from the eastern parts of Clay and Norman counties, where it is very local. At the last-mentioned site, *Cornus alternifolia* was also observed, a shrub species known only from a single site each in Clay and Norman counties.

NORMAN CO.: S 1/2, NE 1/4, Sec. 14, T144N, R43W, 0.5 mi N of Faith on Rte. 40, mesic woodland, 23 May 1988, *Wheeler 10420*; E 1/2, SW 1/4, Sec. 2, T144N, R43W, 2 mi N of Faith, 0.5 mi W of Rte. 40, mesic woodland, 26 May 1988, *Wheeler 10492*.

Carex tuckermanii (Tuckerman's Sedge) is well known from the eastern half of Minnesota, where it grows primarily in wooded swamps and bot-

tomlands (Wheeler & Ownbey 1984). We found a single site for this species in eastern Clay County, where a small population occurs in a wet depression in mesic woodland. Here, *Carex atherodes* is common over large parts of the depression, which has an overstory of *Fraxinus nigra*. Tuckerman's sedge grows in widely-scattered clumps between stands of *Carex atherodes*, in areas sparsely vegetated except for species such as *Carex intumescens* var. *fernaldii, C. stipata,* and *Ranunculus abortivus.*

Trees in the surrounding woodland include, among others, *Betula papyrifera, Ostrya virginiana, Populus grandidentata, Quercus rubra, Tilia americana,* and, less commonly, *Acer saccharum.* Notable understory species are *Carex convoluta, Desmodium glutinosum, Hepatica americana,* and *Monotropa uniflora,* all of which are uncommon in the study area, and *Cornus rugosa* (Round-leaved Dogwood), which is known from the study area only from this site. Typical mosses are *Anomodon minor, Entodon cladorrhizans, Mnium cuspidatum*, and, less frequently, *Anomodon attenuatus, A. rostratus, Brachythecium acuminatum,* and *Lindbergia brachyptera.*

CLAY CO.: NE 1/4, SW 1/4, Sec. 2, T138N, R44W, 4 mi NNE of Rollag, 0.4 mi E of Rte. 37, wet depression in mesic woodland, 6 Jun 1988, *Wheeler 10671.*

Specimen citation for *Cornus rugosa:*

CLAY CO.: NE 1/4, SW 1/4, Sec. 2, T138N, R44W, 4 mi NNE of Rollag, 0.4 mi E of Rte. 37, mesic woodland, 6 Jun 1988, *Wheeler 10652.*

Cladium mariscoides (Twig-rush) is best known from northern Minnesota (e.g., Wheeler & Glaser 1979), but a few small populations are isolated in calcareous fens in the prairie region (Smith 1988). Although previously collected in adjacent Mahnomen and Becker counties, this species was unknown from the six-county area until discovered during this survey at a single site in southeastern Norman County. Here it grows in a relatively level, open, calcareous fen situated near the southern end of the Faith wetland complex. This complex, near the town of Faith, is on the west margin of the Mahnomen Lacustrine Plain adjacent to gently rolling ground moraine (University of Minnesota, Dept. of Soil Science 1980).

The twig-rush is most common in the northern part of the fen, where it grows in meadow-like areas. It is less frequent in places where marly substrate is exposed and uncommon where the terrain is extremely hummocky. Other species associated with it are *Aster junciformis, Galium boreale* var. *septentrionalis, Muhlenbergia glomerata, Lysimachia quadriflora, Triglochin maritima,* and, less frequently, *Gentianopsis procera, Pedicularis lanceolata,* and *Tofieldia glutinosa.*

NORMAN CO.: SW 1/4, NW 1/4, T144N, R43W, Sec. 35, 7 mi ESE of Twin Valley, 0.6 mi W of Rte. 40, calcareous fen, 18 Aug 1988, *Wheeler 11884.*

Some additional description of this fen seems warranted in light of its exceptional diversity, including the presence of 7 state-listed taxa. The pronounced hummocky aspect of the terrain in the southern and western portions of the fen reflects the predominance in these areas of *Carex sterilis* and *Scirpus cespitosus* var. *callosus*, both of which grow in dense tussocks. Species growing between the tussocks include *Carex limosa, C. viridula, Eleocharis compressa,* and *Juncus alpinoarticulatus*, with scattered plants of *Betula glandulifera. Scirpus cespitosus* var. *callosus* is another species that is best known from wetlands in the forested region of northern Minnesota (Glaser 1983) but that has populations isolated in calcareous fens in the prairie region, including several in Clay and Norman counties. *Carex sterilis*, on the other hand, is limited in Minnesota to prairie fens (Smith 1988).

Towards the center of the fen, patches of exposed marl and small, shallow pools of standing water are common. The calciphiles *Rhynchospora capillacea, Scleria verticillata,* and *Triglochin palustris* are common here on the marly substrate, the first growing in profusion in places. The pools harbor few species except an alga in the Characeae (presumably *Nitella*) and, less frequently, *Utricularia minor. Triglochin palustris, Lobelia kalmii,* and *Parnassia palustris* var. *neogaea* are common on the low grassy hummocks of *Muhlenbergia richardsonis* in this area, with *Agalinis paupercula* less frequent. The diminutive *Primula mistassinica*, which is conspicuous only when in flower or fruit, also grows near the pools, the plants having their basal rosettes of leaves embedded in the mosses of the low hummocks. One other occurrence of this disjunct from eastern Minnesota is known in the study area, from a similar, smaller fen in the Faith complex about 2.5 km northeast of this one (Fig. 8) (see also discussion of *Eleocharis rostellata* below in Section IV).

The most common mosses in the fen are *Aulacomnium palustre* and *Tomenthypnum nitens*, and others are *Bryum pseudotriquetrum, Drepanocladus aduncus, Helodium blandowii, Hypnum lindbergii,* and *Thuidium recognitum.* As is typical of western prairie fens, there is no *Sphagnum,* in contrast to bogs and fens in the forested part of northern Minnesota, where *Sphagnum* communities play a very conspicuous and important role (e.g., Janssens and Glaser 1985).

Osmunda cinnamomea (Cinnamon Fern) is well known from much of the eastern half of Minnesota, where it grows in wet woodlands, marshes, and wooded swamps (Tryon 1980). We discovered a single site for this species in the study area, at the Barlage Center for Science in Clay County, where it grows in swampy places in riverine woodland along the Buffalo River. Two other species growing at this site that are very uncommon in the study area are *Carex disperma* and *C. leptalea*. Other conspicuous taxa here are *Caltha palustris, Carex aurea, C. granularis* var. *haleana, Impatiens capensis*, and the bryophytes *Amblystegium serpens, Brachythecium rivulare, Campylium hispidulum, Conocephalum conicum, Leptobryum pyriforme,* and *Timmia megapolitana.*

CLAY CO.: SW 1/4, NE 1/4, Sec. 11, T139N, R46W, 14.5 mi E of Moorhead, Barlage Center for Science, swampy woodland bordering S bank of Buffalo River, 8 Jun 1988, *Wheeler 10688.*

Trientalis borealis (Star-flower) occurs primarily in the northern half of Minnesota, where it grows in mesic to moist forests and on the edges of "bogs" (Morley 1969). We discovered a small population of this species in eastern Norman County, in moist to wet woodland dominated by *Fraxinus nigra.* Other taxa growing at this site that are uncommon or infrequent in the study area include *Anemone quinquefolia* var. *bifolia, Asarum canadense, Carex intumescens* var. *fernaldii, Hepatica americana*, and *Streptopus roseus* (Rose-mandarin), the last of which is also known in the six-county area only from this site.

NORMAN CO.: S 1/2, NE 1/4, Sec. 14, T144N, R43W, 0.5 mi N of Faith on Rte. 40, moist to wet woodland, 23 May 1988, *Wheeler 10395.*

Specimen citation for *Streptopus roseus*:

NORMAN CO.: S 1/2, NE 1/4, Sec. 14, T144N, R43W, 0.5 mi N of Faith on Rte. 40, moist to wet woodland, 23 May 1988, *Wheeler 10397.*

GROUP II: Taxa newly recorded for Minnesota.

We discovered *Fimbristylis puberula* during this survey at a site in Wilkin County about 450 km from the nearest known population, in Holt County, Nebraska (GPFA 1977). The Minnesota plants are assignable to *F. puberula* var. *interior*, as circumscribed by Kral (1971). The habitat of this variety is described as "Wet, sandy clay prairies, subirrigated meadows, shorelines of lakes & ponds" (Kolstad 1986).

The Wilkin County site is a small calcareous fen perched on the west-facing slope of a low beach ridge of Glacial Lake Agassiz. Plants of *Fimbristylis puberula* var. *interior* are restricted to a very wet, quaking part of the fen where they grow on low, grassy hummocks. Conspicuous grasses on the hummocks are *Muhlenbergia richardsonis, M. glomerata,* and, less frequently, *Andropogon gerardii.* In the marly substrate between hummocks, *Rhynchospora capillacea, Scleria verticillata*, and *Triglochin palustris* are common. Other typical fen species present are *Agalinis paupercula, Lobelia kalmii, Salix candida*, and *Solidago riddellii.* This fen in Wilkin County appears to be typical of those in the region, and why *Fimbristylis puberula* var. *interior* should occur only here is unknown.

WILKIN CO.: SW 1/4, NW 1/4, SE 1/4, Sec. 33, T136N, R45W, 6.1 mi NW of Rothsay, 0.1 mi SW of Rte. 52, calcareous fen, 7 Aug 1987, *Dana 87017.*

Eragrostis minor, an introduced grass, was found at two sites in the study area, where it grows in disturbed sandy soil. This taxon is known from scattered localities in the Great Plains, but it is not common (GPFA 1986).

CLAY CO.: E 1/2, SE 1/4, Sec. 12, T139N, R44W, 5.8 mi E of Hawley, less than 0.1 mi E of Rte. 118, sandy soil along access road to W shore of Sand Lake, 5 Sep 1988, *Wheeler 12077*. TRAVERSE CO.: NW 1/4, Sec. 14, T126N, R48W, 10 mi SW of Wheaton, 1 mi W of Rte. 27, sandy soil along access road to E shore of Lake Traverse, 14 Jul 1988, Wheeler 11054.

GROUP III: Taxa collected in the state for the first time in over 25 years.

The only Minnesota record of *Carex xerantica* (Dry Sedge) prior to the 1987–88 survey was from bluff-tops bordering Watab Lake in northern Cook County (Butters & Abbe 1953; Wheeler & Ownbey 1984; Smith 1988). While this sedge has been reported from prairies and wooded slopes in adjacent North and South Dakota (GPFA 1986) and Manitoba (Scoggan 1978), this is the first report of it from the prairies of western Minnesota. This member of the difficult *Ovales* group is best distinguished by its stiff, brownish white inflorescence and perigynia that, when mature, are golden yellow proximally.

We encountered a single plant with mature perigynia in the Felton Prairie in northern Clay County, where it was growing in gently undulating, dry-mesic prairie on sandy loam soil formed in shoreline deposits of Glacial Lake Agassiz. Although the vegetation in the immediate vicinity of the plant was not noted, typical species of drier prairie here are *Amorpha canescens, Aster sericeus, Bouteloua curtipendula, B. gracilis, Echinacea angustifolia, Liatris punctata, Poa pratensis, Pulsatilla nuttalliana, Schizachyrium scoparium, Solidago missouriensis, Sporobolus heterolepis,* and *Stipa spartea. Andropogon gerardii* is important where conditions are more mesic. The part of the Felton Prairie where *Carex xerantica* was collected, Bicentennial Prairie, is a state Scientific and Natural Area (SNA) that has been intensively surveyed in the past, suggesting that the species is quite rare here. However, there are several hundred acres of similar habitat surrounding the SNA, much of which is poorly collected.

CLAY CO.: N 1/2, SW 1/4, Sec. 5, T141N, R45W, 3.4 mi ESE of Felton, Bicentennial Prairie SNA, dry-mesic prairie, 13 Jun 1987, *Dana 87022*.

Prior to this survey, *Cyperus acuminatus* (Short-pointed Umbrella-sedge) was known from only three sites in south-central and southwestern Minnesota, with all collections coming from shallow pools on bedrock outcrops (Smith 1988). But this survey demonstrates that this species also frequents "Shorelines. . .& other low, wet areas" (Kolstad 1986) in Minnesota, as we discovered it growing 1) on the west shore of Barry Lake in northwestern Big Stone County, 2) along the northern margin of a small prairie pond in southeastern Big Stone County, and 3) on the broad, flat, muddy margin of a small prairie pond in southern Traverse County. However, fewer than five plants were observed at any of these sites. Moreover, *C. acuminatus* was observed at only three of the more than 75 lake shores and prairie ponds searched for rarities, indicating that it is indeed rare in the six-county area. Although this species has also been reported from "stream

banks" in the Great Plains (Kolstad 1986), thus far it is unknown from this habitat-type in Minnesota.

BIG STONE CO.: W 1/2, SE 1/4, NE 1/4, Sec. 8, T124N, R47W, 1 mi NW of Barry, 0.7 mi E of Rte. 57, moist margin of W shore of Barry Lake, 19 Jul 1988, *Wheeler 11214;* SW 1/4, NE 1/4, SW 1/4, Sec. 2, T121N, R44W, 6 mi N of Correll, 0.3 mi N of Rte. 64, moist margin of N shore of kettle pond, 21 Jul 1988, *Wheeler 11249.* TRAVERSE CO.: NW 1/4, NW 1/4, Sec. 32, T125N, R47W, 10.5 mi E of Browns Valley, less than 0.1 mi E of Rte. 57, muddy margin of S shore of kettle pond, 23 Jul 1988, *Wheeler 11309.*

Desmanthus illinoensis (Prairie Mimosa) was known in Minnesota from only a few scattered localities in the south and west prior to this survey (Smith 1988), and very little was known about its ecology in the state. We discovered twelve new sites for this species in the study area, 10 in Big Stone County and two in Traverse, as well as three sites in adjacent Stevens County (i.e., at Gorder Lake, Lake Hattie, and Page Lake). At the majority of these new sites this species is uncommon to occasional in occurrence, although at a few sites it is locally abundant. This distinctive legume grows primarily on the moist, sandy shores of lakes and along the margins of prairie ponds, but at some favored localities it also occurs in wet-mesic prairie. The plants flower from June through August and the conspicuous falcate fruits (i.e., the legumes), which are tightly compacted into a more or less subglobose head, are often persistent on the peduncles well into October (Fig. 15).

On the margins of lakes and prairie ponds, *Desmanthus illinoensis* generally grows with a characteristic suite of species, the most notable being *Artemisia biennis, Bidens cernua, Chenopodium rubrum, Cyperus erythrorhizos, C. odoratus, Panicum capillare, Polygonum lapathifolium, Rumex maritimus* var. *fueginus*, and, less frequently, *Aster brachyactis, Bidens frondosa, Carex sychnocephala, Chenopodium glaucum, Lotus purshianus, Potentilla paradoxa, Rumex stenophyllus,* and the rarity *Cyperus acuminatus.* The prairie mimosa may be easily overlooked on the margins of prairie ponds, where it is often obscured by the dense growth of tall plants such as *Artemisia biennis* and *Chenopodium rubrum* and the much-branched, bushy panicles of *Panicum capillare.* It is generally more exposed on the sparsely vegetated, sandy shorelines of lakes.

Only at two favored localities in southern Traverse County was *Desmanthus* observed growing in wet-mesic prairie, in each case on a somewhat concave, relatively narrow strip of slightly elevated land that separates two or more prairie ponds. At both sites, *Desmanthus* is most abundant toward the lower, central portion of the prairie, where the water table is closest to the surface. Among the species it grows with here are *Andropogon gerardii, Aster ericoides, Helianthus maximilianii, Poa pratensis, Rosa arkansana, Solidago rigida,* and *Sporobolus asper.* At both sites, however, it is very uncommon on the moderate slopes that surround the ponds, even though they harbor many prairie species.

Desmanthus illinoensis is invariably absent from the shores of lakes and

FIGURE 15. Shoot of *Desmanthus illinoensis* showing the conspicuous cluster of dark fruits. The most recent report of this species in Minnesota prior to this study was in 1958. Although it is commonly known as the prairie mimosa, it was found in the study area primarily on sandy lake and pond margins, and only twice in prairie vegetation. 25 September 1988.

ponds having a mud substrate, as opposed to a sandy one; therefore, it seldom, if ever, grows in places dominated by *Sparganium* and *Typha*. Enigmatically, it was not observed along the banks of rivers and creeks, even though many of them have sandy margins and, indeed, harbor some (if not most) of the same species that grow with *Desmanthus* elsewhere in the study area. The restriction of *Desmanthus illinoensis* to transition habitats, sites which are often neglected by plant ecologists and plant collectors looking for rarities, seems to be one of the reasons why this conspicuous species has been greatly overlooked in western Minnesota in the past.

Representative specimens. BIG STONE CO.: W 1/2, NE 1/4, SE 1/4, Sec. 17, T124N, R46W, near SW side of Graceville, 1.1 mi W of Rte. 75, moist margin of E shore of West Toqua Lake, 18 Jul 1988, *Wheeler 11189*; SE 1/4, NW 1/4, Sec. 8, T124N, R47W, 1.2 mi NW of Barry, 0.3 mi E of Rte. 57, moist margin of partially

dried-up kettle pond, 19 Jul 1988, *Wheeler 11196*; SW 1/4, SE 1/4, Sec. 2, T121N, R44W, 6 mi N of Correll, less than 0.1 mi N of Rte. 64, moist margin of kettle pond, 21 Jul 1988, *Wheeler 11246*; NE 1/4, SW 1/4, NE 1/4, Sec. 14, T122N, R44W, 10.5 mi N of Correll, 0.2 mi SW of Rte. 10, moist sandy margin of Artichoke Lake, 28 Jul 1988, *Wheeler 11576*; NW 1/4, SW 1/4, NE 1/4, Sec. 12, T121N, R46W, 2.5 mi ENE of Ortonville, 0.2 mi S of Rte. 64, moderate slope bordering N bank of kettle pond, 11 Sep 1988, *Wheeler 12232*. STEVENS CO.: NW 1/4, NW 1/4, NW 1/4, Sec. 36, T124N, R43W, 7 mi SW of Morris, moist sandy margin of S shore of Gorder Lake, 29 Jul 1988, *Wheeler 11588*. TRAVERSE CO.: SW 1/4, SE 1/4, SE 1/4, Sec. 32, T125N, R46W, 17 mi E of Browns Valley, less than 0.1 mi N of Rte. 2, wet-mesic prairie strip between two kettle ponds, 19 Jul 1988, *Wheeler 11232*; S 1/2, SE 1/4, SW 1/4, Sec. 29, T125N, R47W, 11 mi E of Browns Valley, less than 0.1 mi N of Rte. 2, wet-mesic prairie strip bordering kettle pond, 23 Jul 1988, *Wheeler 11306*.

GROUP IV: Other notable taxa.

We discovered a small population of *Bacopa rotundifolia* (Water-hyssop) on the margin of the prairie pond in Traverse County where *Cyperus acuminatus* (mentioned above in Group III) was found. Altogether, eight sprawling, somewhat circular, mats of this species were seen scattered about the southern end of the pond. Other species growing at this site are *Polygonum lapathifolium, Portulaca oleracea,* and *Ranunculus sceleratus*. Most Minnesota collections of *Bacopa rotundifolia,* like those of *Cyperus acuminatus,* come from shallow pools on rock outcrops (Smith 1988).

TRAVERSE CO.: NW 1/4, NW 1/4, Sec. 32, T125N, R47W, 10.5 mi E of Browns Valley, less than 0.1 mi E of Rte. 57, muddy margin of S shore of kettle pond, 23 Jul 1988, *Wheeler 11310*.

Prior to this survey, *Botrychium campestre* (Prairie Moonwort) was known from six sites in western Minnesota, with one each in Lac Qui Parle, Big Stone, and Norman counties (Wagner & Wagner 1986, Minnesota Natural Heritage Program database, unpublished). Cindy Johnson-Groh and coworkers, who conducted an intensive field survey for this species in the six-county study area in 1988, discovered it in Traverse and Clay counties. In all, these workers recorded 13 new sites for this species, four in Lac Qui Parle County and three each in Big Stone, Clay, and Traverse counties.

This diminutive fern was found in well-drained, gravelly, hill prairies, generally in mid-slope on mostly north- and west-facing aspects of gentle slope. In addition to *Poa pratensis,* other species it commonly grows with are *Amorpha canescens, Bouteloua curtipendula, Oxalis violacea, Pulsatilla nuttalliana, Schizachyrium scoparium, Stipa spartea*, and, somewhat less frequently, *Echinacea angustifolia, Geum triflorum, Heuchera richardsonii, Potentilla arguta,* and *Symphoricarpos occidentalis.* This species is most visible in late May and early June, when the plants have reached their full height (5–10 cm) and are releasing spores. The plants, which seemingly produce little chlorophyll, appear to be mycorrhizal.

(We provide no specimen citations as we made no collections of this taxon.)

Carex capillaris var. *major* (Hair-like Sedge) is a sedge of infrequent occurrence in northern Minnesota, probably best known from Lake Itasca (Clearwater County), where it grows primarily in alder swamps, along shaded lake shores, and in other well-shaded, swampy places (Wheeler & Ownbey 1984). We discovered it at a single site in Norman County in an alder swamp, a habitat-type very rare in the six-county area. Other taxa growing at this site that were previously unknown from the study area include *Alnus incana* ssp. *rugosa, Carex disperma, C. leptalea, Dryopteris cristata, Ribes hirtellum,* and *Thelypteris palustris* var. *pubescens.* All these taxa except *A. incana* ssp. *rugosa* and *D. cristata* were recorded from at least one additional site in the study area during this survey.

NORMAN CO.: E 1/2, NE 1/4, NW 1/4, Sec. 22, T144N, R43W, 6.5 mi ENE of Twin Valley, alder swamp bordering S bank of Wild Rice River, 31 May 1988, *Wheeler 10540.*

Chamaerhodos nuttallii (Nuttall's Ground-rose) is known from a few scattered sites in northwestern Minnesota (Smith 1988). During this survey we recorded it from five new sites in Clay County, most in an area of hilly, dissected outwash in the southeast part of the county (Fig. 2), where the plant is largely restricted to gravelly slopes, gravel pits, and road cuts. The largest populations grow on steep, gravelly sites that are sparsely vegetated; smaller populations, which are indeed sometimes limited to only a few plants, occasionally occur on slopes that support a denser prairie cover. This species was also recorded from 10 sites in adjacent Becker County in the same outwash formation; these are the easternmost records in the state.

Chamaerhodos nuttallii grows with species such as *Artemisia frigida, Aster ericoides, Bouteloua curtipendula, B. gracilis, Koeleria macrantha, Stipa comata,* and, less frequently, *Calylophus serrulatus, Carex filifolia, Castilleja sessiliflora, Linum rigidum, Penstemon albidus,* and *Psoralea esculenta.* Sand and gravel mining in the area will probably destroy some *Chamaerhodos* populations, but it will also create new habitat and probably result in the establishment of new populations.

Representative specimens. BECKER CO.: NW 1/4, SE 1/4, Sec. 32, T138N, R43W, 14.5 mi SW of Detroit Lakes, waterfowl area 0.4 mi W of unmarked county road, summit of gravelly morainic hill, 22 Jun 1988, *Wheeler 10824.* CLAY CO.: E 1/2, NE 1/4, NW 1/4, Sec. 35, T138N, R44W, 11 mi NE of Barnesville, 0.5 mi E of Rte. 125, gravel prairie on W-facing slope of morainic hill, 22 Jun 1988, *Wheeler 10807*; NW 1/4, NW 1/4, NW 1/4, Sec. 2, T137N, R44W, 10 mi NE of Barnesville, E of Rte. 125, gravelly W-facing road cut, 22 Jun 1988, *Wheeler 10815.*

Eleocharis rostellata (Beaked Spike-rush) had not been collected in the six-county study area prior to this survey, although it was known from fens in adjoining Becker and Mahnomen counties (Smith 1988). We discovered it in the fen near Faith where *Cladium mariscoides* and *Agalinis paupercula* were found (discussed earlier in Group I). The beaked spike-rush, which often spreads by long, arching sterile culms that root at the tip (see Glaser

[1983] and Smith [1988] for ecological notes on this species), seemingly is restricted to the western part of the fen, where it is abundant in places.

NORMAN CO.: SW 1/4, NW 1/4, Sec. 35, T144N, R43W, 7 mi ESE of Twin Valley, 0.6 mi W of Rte. 40, calcareous fen, 18 Aug 1988, *Wheeler 11885*.

Oryzopsis hymenoides (Indian Ricegrass) is only known in Minnesota from a sand dune complex in Polk and Norman counties, where it is disjunct by some 300 km from the main range in North and South Dakota (Smith 1988). The original collection of this species was from Polk County, just north of the study area in one of the larger dune areas (Agassiz Dunes Scientific and Natural Area), where there has been no confirmed sighting in more than 25 years. During preliminary survey work in 1985 we discovered a population in the other large dune area in Polk County, north of the original site (Fig. 12), and another population in Norman County, in a small dune blanket ("Agsco Dunes") 3 km south of the main complex. At the latter site a small number of vigorous tufts of *Oryzopsis hymenoides* grow in the barren sand of a disturbance created by cattle activity. Two other state rarities occurring at this site are *Shinnersoseris rostrata* and *Triplasis purpurea* (Ownbey & Smith 1988, Smith 1988). The former is also known from dune areas in the main complex, but the latter, which is restricted to the same disturbance as the Oryzopsis, has not been observed elsewhere in the complex.

Typical species at the Agsco Dunes are *Calamovilfa longifolia, Carex foenea, Cenchrus longispinus, Cyperus schweinitzii, Elymus canadensis, Heterotheca villosa, Petalostemon villosum, Schizachyrium scoparium, Sporobolus cryptandrus*, and less frequently, *Chenopodium desiccatum, Corispermum hyssopifolium, Euphorbia geyeri, and Oenothera nuttallii*. The dunes are surrounded by successional woodland of *Quercus macrocarpa, Fraxinus pennsylvanica, Populus tremuloides*, and *Tilia americana*, and stunted *Quercus macrocarpa* are scattered throughout the dunes. Where woodland gives way to dunes, *Selaginella rupestris* is sometimes present, particularly on dune summits, where it grows in more or less extensive mats. Elsewhere, the above-mentioned arenicolous species dot the dune landscape and the mosses *Ceratodon purpureus* and *Tortula ruralis* are common on sterile soils.

NORMAN CO.: NE 1/4, SE 1/4, Sec. 18, T146N, R44W, 6.5 mi NNW of Gary, Agsco Dunes, sand dune, 11 Aug 1988, *Wheeler 11645*.

CATALOGUE OF VASCULAR PLANTS AND MOSSES

The nomenclature and sequence of families in the catalogue of vascular plants follows that of Ownbey and Morley (1991), with genera and species alphabetically arranged. Taxa newly recorded in the six-county area are preceded by a dagger †; non-native taxa are preceded by an asterisk. Plants

legally listed as endangered (4 taxa), threatened (9 taxa), and special concern (29 taxa) in Minnesota are indicated by E, T, and C, respectively, and those proposed for listing (1, 3, and 1 taxa, respectively) are indicated by P prefixed to the code for the proposed status. State rarities tracked by the Natural Heritage Program but for which no legal status has been proposed are indicated by U. Lastly, taxa with a superscript (i.e., those having a "1" following the name) have been reported by Ownbey and Morley (1991) as occurring in one or more of the six counties surveyed, although according to the Great Plains Flora Association (1986) they do not occur in the Great Plains. We have not attempted to address the taxonomic issues involved in these cases.

The nomenclature and familial placement of species in the catalogue of mosses follows that of Crum and Anderson (1981). "Western Minnesota" refers to the 37 counties (totally or in part) that lie in the Great Plains, as defined by the Great Plains Flora Association (1977, 1986) and adopted by Churchill (1976). Mosses recorded during this survey that have been previously reported from western Minnesota (Churchill 1976) are preceded by a plus sign. Mosses recorded from the study area that are new records for western Minnesota are preceded by two plus signs. Mosses without a symbol, although previously reported from western Minnesota (Churchill 1976), were not recorded from the study area during this survey. It should be noted that not all of the mosses reported from western Minnesota by Churchill were necessarily based on specimens collected in one or more of the six counties treated in this paper.

CHECKLIST OF VASCULAR PLANTS

(Lac Qui Parle, Big Stone, Traverse, Wilkin, Clay, Norman)

PTERIDOPHYTES

SELAGINELLACEAE							
	Selaginella rupestris (L.) Spring	L	B	.	.	.	N
EQUISETACEAE							
	Equisetum arvense L.	L	B	T	W	C	N
	Equisetum ×*ferrissii* Clute	L	B	.	W	C	N
	Equisetum fluviatile L.	.	.	.	W	C	.
	Equisetum hyemale L.						
	var. *affine* (Engelm.) A. A. Eaton	L	B	T	W	C	N
	Equisetum laevigatum A. Braun	L	B	T	W	C	N
	Equisetum pratense Ehrh.	.	.	.	W	.	.
OPHIOGLOSSACEAE							
PT	*Botrychium campestre* W. H. Wagner & Farrar	L	B	T	.	C	N
U	*Botrychium minganense* Vict.	.	.	.	.	.	N
	Botrychium multifidum (S. Gmelin) Rupr.	.	.	.	.	C	N
†	*Botrychium simplex* Hitchc.	.	.	.	.	C	N
	Botrychium virginianum (L.) Sw.	.	.	.	.	C	N
OSMUNDACEAE							
†	*Osmunda cinnamomea* L.	.	.	.	.	C	.
POLYPODIACEAE							
	Athyrium angustum (Willd.) C. Presl	.	.	.	.	C	N

	Cystopteris fragilis (L.) Bernh.	.	.	.	.	C	.
†	*Dryopteris cristata* (L.) A. Gray	.	.	.	.	.	N
†	*Dryopteris spinulosa* (Mueller) Watt var. *spinulosa*	.	.	.	.	.	N
†	*Matteuccia struthiopteris* (L.) Todaro	.	.	.	.	C	N
	Onoclea sensibilis L.	.	.	.	.	C	.
†	*Pteridium aquilinum* (L.) Kuhn var. *latiusculum* (Desv.) L. Underw.	.	.	.	.	.	N
†	*Thelypteris palustris* Schott	.	.	.	.	C	N
	Woodsia ilvensis (L.) R. Br.	.	B	.	.	.	.
	Woodsia oregana D. C. Eaton	L	.	.	.	.	.
	GYMNOSPERMS						
CUPRESSACEAE							
	Juniperus communis L. var. *depressa* Pursh	.	.	.	.	.	N
	Juniperus horizontalis Moench	.	.	.	.	.	N
	Juniperus virginiana L.	L	B	.	.	C	N
PINACEAE							
	Picea glauca (Moench) A. Voss	.	.	.	.	.	N
	ANGIOSPERMS						
ACERACEAE							
	Acer negundo L.	L	B	T	W	C	N
†	*Acer saccharinum* L.	L	B	.	.	.	.
	Acer saccharum Marshall	.	.	.	.	C	N
AIZOACEAE							
*	*Mollugo verticillata* L.	.	.	.	.	C	.
ALISMATACEAE							
	Alisma gramineum Gmelin	.	B	T	.	C	.
	Alisma subcordatum Raf.	.	.	T	W	C	N
	Alisma triviale Pursh	L	B	.	W	C	N
U	*Sagittaria brevirostra* Mack. & Bush	.	.	.	.	C	.
	Sagittaria cuneata Sheldon	L	B	T	W	.	.
	Sagittaria latifolia Willd.	.	B	.	W	C	N
	Sagittaria rigida Pursh	.	.	.	.	C	.
AMARANTHACEAE							
	Amaranthus albus L.	.	B	.	W	C	.
*	*Amaranthus blitoides* S. Watson	L	B	T	W	C	N
†	*Amaranthus powellii* S. Watson	.	B	.	.	.	.
*	*Amaranthus retroflexus* L.	L	B	T	W	C	N
	Amaranthus tamariscinus Nutt.	L	B	T	W	C	N
	Amaranthus tuberculatus (Moq.) Sauer	L	.	.	.	.	.
AMARYLLIDACEAE							
	Hypoxis hirsuta (L.) Cov.	L	B	.	W	C	N
ANACARDIACEAE							
	Rhus glabra L.	L	B	T	W	C	N
	Rhus radicans L. var. *rydbergii* (Small ex Rydb.) Rehder	L	B	T	W	C	N
APIACEAE							
	Berula pusilla (Nutt.) Fern.	L	.	.	.	.	.
*	*Carum carvi* L.	.	.	.	.	C	.
	Cicuta bulbifera L.	.	.	.	W	C	N
	Cicuta maculata L.	L	B	.	W	C	N
	Cryptotaenia canadensis (L.) DC.	L	B	T	W	C	N
PC	*Cymopterus acaulis* (Pursh) Raf.	.	.	.	.	C	.
	Heracleum lanatum Michaux	L	B	.	W	C	N
	Lomatium orientale J. Coulter & Rose	L	B	T	.	C	.

	Osmorhiza claytonii (Michaux) Clarke	.	B	.	.	C	N
	Osmorhiza longistylis (Torrey) DC.	.	B	.	.	C	N
*	*Pastinaca sativa* L.	.	.	.	W	C	.
	Sanicula gregaria Bickn.	L	B	.	.	.	.
	Sanicula marilandica L.	.	.	T	W	C	N
	Sium suave Walter	L	B	T	W	C	N
	Zizia aptera (A. Gray) Fern.	L	B	T	W	C	N
	Zizia aurea (L.) Koch	L	B	T	W	C	N
APOCYNACEAE							
	Apocynum androsaemifolium L.	.	.	T	.	C	N
	Apocynum cannabinum L.	.	B	.	W	C	.
	Apocynum medium E. Greene	.	.	.	.	C	.
	Apocynum sibiricum Jacq.	L	B	T	W	C	N
ARACEAE							
	Acorus calamus L.	.	.	.	.	C	N
	Arisaema triphyllum (L.) Schott	L	B	.	W	C	N
ARALIACEAE							
	Aralia nudicaulis L.	.	B	.	.	C	N
†	*Aralia racemosa* L.	.	.	.	.	C	N
ARISTOLOCHIACEAE							
†	*Asarum canadense* L.	.	.	.	.	.	N
ASCLEPIADACEAE							
	Asclepias incarnata L.	L	B	T	W	C	N
	Asclepias lanuginosa Nutt.	.	.	.	.	C	N
	Asclepias ovalifolia Decne.	.	B	T	.	C	N
	Asclepias speciosa Torrey	L	B	.	W	C	N
T	*Asclepias sullivantii* Engelm.	.	.	T	.	.	.
	Asclepias syriaca L.	L	B	T	W	C	N
	Ascelpias verticillata L.	L	B	T	W	C	N
	Asclepias viridiflora Raf.	L	B	T	.	C	N
ASTERACEAE							
	Achillea millefolium L.	L	B	T	W	C	N
	Agoseris glauca (Pursh) Raf.	.	B	T	W	C	N
	Ambrosia artemisiifolia L.	L	B	T	W	C	N
	Ambrosia coronopifolia Torrey & A. Gray	L	B	T	W	C	N
	Ambrosia trifida L.	L	B	T	W	C	N
	Antennaria microphylla Rydb.	.	.	.	.	C	.
	Antennaria neglecta E. Greene	L	B	.	.	C	N
	Antennaria neodioica E. Greene	.	.	.	.	C	.
C	*Antennaria parvifolia* Nutt.	.	.	.	W	.	.
	Antennaria plantaginifolia (L.) Richardson[1]	.	.	.	.	C	N
*	*Anthemis cotula* L.	.	.	.	.	C	N
*	*Arctium minus* (Hill) Bernh.	L	B	T	W	C	N
*	*Artemisia absinthium* L.	L	B	T	.	C	N
*	*Artemisia biennis* Willd.	L	B	T	W	C	N
	Artemisia campestris L.	.	.	.	.	C	N
	Artemisia dracunculus L.	.	.	.	W	C	N
	Artemisia frigida Willd.	L	B	T	.	C	N
	Artemisia ludoviciana Nutt.	L	B	T	W	C	N
	Aster borealis (Torrey & A. Gray) Prov.	.	.	.	W	C	N
	Aster brachyactis S. F. Blake	L	B	T	.	C	N
	Aster ciliolatus Lindley	.	.	.	.	C	N
	Aster ericoides L.	L	B	T	W	C	N
	Aster falcatus Lindley	L	.	T	.	C	.
	Aster hesperius A. Gray	.	.	.	W	C	N

		Aster laevis L.	L	B	T	W	C	N
		Aster lanceolatus Willd.	L	B	T	W	C	N
		Aster lateriflorus (L.) Britton	.	.	.	.	C	N
		Aster novae-angliae L.	.	B	.	W	C	N
		Aster oblongifolius Nutt.	L	B	T	.	C	.
†		*Aster ontarionis* Wieg.	L	.	.	.	.	.
†		*Aster puniceus* L. ssp. *firmus* (Nees) A.G. Jones	.	.	.	.	.	N
		Aster sericeus Vent.	L	B	T	.	C	N
		Aster umbellatus Miller	.	B	T	W	C	N
		Bidens cernua L.	L	B	T	W	C	N
		Bidens comosa (A. Gray) Wieg.	L	B	T	W	C	N
		Bidens frondosa L.	L	B	T	W	C	N
		Bidens vulgata E. Greene	L	B	.	W	C	N
		Boltonia asteroides (L.) L'Her. var. *recognita* (Fern. & Griscom) Cronq.	.	.	T	.	C	.
	*	*Carduus acanthoides* L.	.	.	.	.	C	N
	*	*Centaurea biebersteinii* DC.	.	.	.	.	C	.
	*	*Chamomilla suaveolens* (Pursh) Rydb.	L	.	T	W	C	.
†	*	*Chrysanthemum leucanthemum* L.	.	.	.	.	.	N
†	*	*Cichorium intybus* L.	.	.	.	.	.	N
		Cirsium altissimum (L.) Sprengel	.	B	.	.	C	.
	*	*Cirsium arvense* (L.) Scop.	L	B	T	W	C	N
		Cirsium flodmanii (Rydb.) Arthur	L	B	T	W	C	N
		Cirsium muticum Michaux	.	.	.	.	C	N
	*	*Cirsium vulgare* (Savi) Tenore	L	B	T	W	C	N
		Conyza canadensis (L.) Cronq.	L	B	T	W	C	N
†		*Conyza ramosissima* Cronq.	.	.	T	.	.	.
		Crepis runcinata (James) Torrey & A. Gray	L	B	.	W	C	N
	*	*Crepis tectorum* L.	.	.	.	.	C	.
		Echinacea angustifolia DC.	L	B	T	W	C	N
†		*Erigeron annuus* (L.) Pers.	.	.	.	.	.	N
		Erigeron glabellus Nutt.	.	.	.	W	C	N
		Erigeron lonchophyllus Hook.	.	.	.	W	.	N
		Erigeron philadelphicus L.	L	B	T	W	C	N
		Erigeron strigosus Muhlenb.	L	B	T	W	C	N
		Eupatorium maculatum L.	L	B	T	W	C	N
		Eupatorium perfoliatum L.	L	.	.	W	C	N
		Eupatorium rugosum Houtt.	L	B	T	W	C	N
		Euthamia graminifolia (L.) Nutt.	L	B	T	W	C	N
		Euthamia gymnospermoides E. Greene	L	.	.	.	C	.
		Gaillardia aristata Pursh	.	.	.	.	C	N
	*	*Galinsoga quadriradiata* Ruiz & Pavon	.	.	.	.	C	.
		Grindelia squarrosa (Pursh) Dunal	L	B	T	W	C	N
	C	*Haplopappus spinulosus* (Pursh) DC.	L	B	T	.	.	.
		Helenium autumnale L.	L	B	T	W	C	N
	C	*Helianthus annuus* L.	L	B	T	W	C	N
		Helianthus giganteus L.	.	.	.	W	C	.
		Helianthus grosseserratus M. Martens	.	.	.	.	C	.
		Helianthus maximilianii Schrader	L	B	T	W	C	N
	C	*Helianthus nuttallii* Torrey & A. Gray ssp. *rydbergii* (Britton) Long	.	.	.	W	C	N
		Helianthus petiolaris Nutt.	.	.	.	.	C	N
		Helianthus rigidus (Cass.) Desf.	L	B	T	W	C	N
		Helianthus tuberosus L.	.	.	T	.	C	.
		Heliopsis helianthoides (L.) Sweet ssp. *occidentalis* T. Fisher	L	B	T	W	C	N
		Heterotheca villosa (Pursh) Shinners	L	B	T	.	C	N
		Hieracium kalmii L.	.	.	.	.	C	

	Hieracium scabriusculum Schwein.	.	.	.	.	C	N
	Iva xanthifolia Nutt.	L	B	.	W	C	N
	Krigia biflora (Walter) S. F. Blake	.	.	.	.	C	N
	Kuhnia eupatorioides L. var. *corymbulosa* Torrey & A. Gray	L	B	T	.	C	.
	Lactuca biennis (Moench) Fern.	.	.	.	.	C	N
	Lactuca canadensis L.	.	.	.	.	C	.
	Lactuca ludoviciana (Nutt.) Riddell	.	.	.	W	C	.
	Lactuca pulchella (Pursh) DC.	L	B	T	W	C	N
*	*Lactuca serriola* L.	L	B	T	W	C	N
	Liatris aspera Michaux	L	B	.	W	C	N
	Liatris ligulistylis (Nelson) Schumann	.	B	.	W	C	N
	Liatris punctata Hook.	L	B	T	.	C	N
	Liatris pycnostachya Michaux	L	B	.	W	C	N
	Lygodesmia juncea (Pursh) Hook.	L	B	T	W	C	N
	Nothocalais cuspidata (Pursh) E. Greene	L	B	T	.	C	N
	Petasites sagittatus (Banks ex Pursh) A. Gray	.	.	.	.	C	.
	Prenanthes alba L.	.	.	.	W	C	N
	Prenanthes aspera Michaux	L	.	.	.	C	.
	Prenanthes racemosa Michaux	L	.	T	W	C	N
	Ratibida columnifera (Nutt.) Wooton & Standley	L	B	T	W	C	N
	Rudbeckia hirta L. var. *pulcherrima* Farw.	.	.	.	W	C	N
	Rudbeckia laciniata L.	L	B	T	W	C	N
	Senecio aureus L.[1]	.	B	.	W	.	.
	Senecio congestus (R. Br.) DC.	.	B	.	.	C	.
	Senecio integerrimus Nutt.	L	.	.	.	C	N
	Senecio pauperculus Michaux	L	.	.	W	C	N
	Senecio plattensis Nutt.	L	B	T	W	C	N
	Senecio pseudaureus Rydb. var. *semicordatus* (Mackenzie & Bush) T. Barkley	L	.	.	W	C	N
*	*Senecio vulgaris* L.	.	.	.	.	C	.
T	*Shinnersoseris rostrata* (A. Gray) Tomb	.	.	.	.	.	N
	Silphium perfoliatum L.	L	B	.	.	.	.
	Solidago ×*bernardii* Boivin	.	.	.	.	C	N
	Solidago canadensis L.	L	B	T	W	C	N
	Solidago flexicaulis L.	L	B	T	W	C	N
	Solidago gigantea Aiton	.	B	T	W	C	N
	Solidago hispida Muhlenb.	.	.	.	.	.	N
	Solidago missouriensis Nutt.	.	.	T	W	C	N
C	*Solidago mollis* Bartling	L	B	T	.	.	.
	Solidago nemoralis Aiton	L	B	T	W	C	N
	Solidago ptarmicoides (Nees) Boivin	.	B	T	W	C	N
	Solidago riddellii Frank	.	.	.	W	C	N
	Solidago rigida L.	L	B	T	W	C	N
	Solidago speciosa Nutt.	L	B	.	.	C	N
*	*Sonchus asper* (L.) Hill	.	.	.	.	C	N
*	*Sonchus oleraceus* L.	.	B	.	W	C	N
*	*Sonchus uliginosus* M. Bieb.	L	B	T	W	C	N
† *	*Tanacetum vulgare* L.	.	.	.	W	.	.
*	*Taraxacum erythrospermum* Andrz.	.	.	.	.	C	.
*	*Taraxacum officinale* Weber	L	B	T	W	C	N
	Tragopogon dubius Scop.	L	B	T	W	C	N
	Vernonia fasciculata Michaux	L	B	T	W	C	N
	Xanthium strumarium L.	L	B	T	W	C	N
BALSAMINACEAE							
	Impatiens capensis Meerb.	L	B	T	W	C	N
	Impatiens pallida Nutt.	.	B	.	.	.	.

BERBERIDACEAE							
	Caulophyllum thalictroides (L.) Michaux	.	.	.	.	C	N
BETULACEAE							
†	*Alnus incana* (L.) Moench						
	ssp. *rugosa* (Duroi) R.T. Clausen	.	.	.	.	.	N
	Betula glandulifera (Regel) Butler	.	.	.	.	C	N
	Betula papyrifera Marshall	.	.	.	.	C	N
	Betula ×*sandbergii* Britton	.	.	.	.	C	.
	Corylus americana Walter	.	.	T	.	C	N
	Ostrya virginiana (Miller) K. Koch	.	B	T	.	C	N
BORAGINACEAE							
*	*Cynoglossum officinale* L.	.	.	.	.	.	N
	Hackelia deflexa (Wahlenb.) Opiz						
	var. *americana* (A. Gray) Fern. & I. M. Johnston	.	B	.	W	C	.
	Hackelia virginiana (L.) I. M. Johnston	L	B	T	W	C	N
*	*Lappula redowskii* (Hornem.) E. Greene	.	.	.	W	C	.
*	*Lappula squarrosa* (Retz.) Dumort.	L	B	T	W	C	N
	Lithospermum canescens (Michaux) Lehm.	L	B	T	W	C	N
	Lithospermum incisum Lehm.	L	B	T	.	C	N
	Lithospermum latifolium Michaux	.	.	T	.	C	.
	Mertensia paniculata (Aiton) G. Don	.	.	.	.	C	.
U	*Myosotis verna* Nutt.	.	B	.	.	.	.
	Onosmodium molle Michaux						
	ssp. *occidentale* (Mackenzie) Cochrane	L	B	T	W	C	N
	ssp. *hispidissimum* (Mackenzie) Cochrane	.	.	.	.	.	N
BRASSICACEAE							
	Arabis divaricarpa Nelson	.	.	.	.	C	.
	Arabis hirsuta (L.) Scop.	L	.	.	.	C	N
*	*Armoracia rusticana* Gaertner, Meyer & Scherbius	.	.	.	.	C	.
*	*Barbarea vulgaris* R. Br.	.	.	.	.	C	N
*	*Berteroa incana* (L.) DC.	L	B	T	.	C	N
*	*Brassica juncea* (L.) Czernj.	.	.	.	.	C	.
*	*Brassica kaber* (DC.) Wheeler	L	B	T	W	C	N
*	*Brassica nigra* (L.) Koch	.	.	.	W	.	.
*	*Camelina microcarpa* Andrz. ex DC.	.	.	.	.	C	N
*	*Capsella bursa-pastoris* (L.) Medikus	L	B	T	W	C	N
	Cardamine bulbosa (Schreb.) B.S.P.	L	B	T	W	C	N
	Cardamine pensylvanica Muhlenb.	.	.	.	.	C	.
	Descurainia pinnata (Walter) Britton						
	var. *brachycarpa* (Richardson) Fern.	.	B	.	.	C	.
	Descurainia richardsonii (Sweet) O. Schulz	.	B	.	.	.	.
*	*Descurainia sophia* (L.) Webb ex Prantl	L	B	T	W	C	N
	Draba nemorosa L.	.	B	.	.	C	.
	Draba reptans (Lam.) Fern.	L	B	.	.	C	.
*	*Erucastrum gallicum* (Willd.) O. Schulz	.	B	T	W	C	N
	Erysimum asperum (Nutt.) DC.	.	.	.	.	C	.
	Erysimum cheiranthoides L.	.	.	T	W	C	.
	Erysimum inconspicuum (S. Watson) MacMillan	L	B	T	.	C	N
*	*Hesperis matronalis* L.	L	B	.	.	C	N
	Lepidium densiflorum Schrader	L	B	T	W	C	N
	Rorippa islandica (Oeder) Borbas	L	B	T	W	C	N
*	*Sisymbrium altissimum* L.	.	B	T	W	C	N
*	*Sisymbrium loeselii* L.	.	B	.	.	C	.
*	*Thlaspi arvense* L.	L	.	T	W	C	N
CACTACEAE							
T	*Coryphantha vivipara* (Nutt.) Britton & Rose	.	B	.	.	.	.

		Opuntia fragilis (Nutt.) Haw.	L	B	.	.	.	.
CALLITRICHACEAE								
		Callitriche hermaphroditica L.	.	.	T	.	.	.
	U	*Callitriche heterophylla* Pursh	.	B	.	.	.	.
		Callitriche verna L.	.	B	.	.	.	.
CAMPANULACEAE								
†		*Campanula americana* L.	L	B	.	.	.	.
		Campanula aparinoides Pursh	.	.	.	W	C	N
	*	*Campanula rapunculoides* L.	.	.	.	.	C	.
		Campanula rotundifolia L.	.	B	T	W	C	N
		Lobelia kalmii L.	.	.	.	W	C	N
		Lobelia siphilitica L.	L	B	.	.	C	N
		Lobelia spicata Lam.	.	B	T	W	C	N
CAPPARACEAE								
		Polanisia dodecandra (L.) DC.	.	.	.	.	C	.
CAPRIFOLIACEAE								
		Lonicera dioica L.	.	B	T	.	C	N
	*	*Lonicera tatarica* L.	L	B	T	W	C	N
		Sambucus canadensis L.	L	.	T	.	C	N
		Symphoricarpos occidentalis Hook.	L	B	T	W	C	N
†		*Triosteum perfoliatum* L.	.	.	.	.	.	N
		Viburnum lentago L.	.	B	.	.	C	N
		Viburnum rafinesquianum Schultes	.	.	.	.	C	N
		Viburnum trilobum Marshall	.	.	.	.	C	N
CARYOPHYLLACEAE								
		Arenaria lateriflora L.	L	B	T	W	C	N
		Cerastium arvense L.	L	.	T	.	C	N
	U	*Cerastium brachypodum* (Engelm. ex A. Gray) Robinson	.	B	.	.	.	.
	*	*Cerastium fontanum* Baumg.	.	.	.	.	C	N
		Cerastium nutans Raf.	.	B	.	.	.	.
†	*	*Myosoton aquaticum* (L.) Moench	L	B	.	.	.	.
	*	*Saponaria officinalis* L.	.	.	.	.	C	.
		Silene antirrhina L.	.	.	.	.	C	N
	*	*Silene cserei* Baumg.	L	B	T	.	C	N
	U	*Silene drummondii* Hook.	.	.	.	.	C	.
	*	*Silene noctiflora* L.	.	.	.	.	C	.
	*	*Silene latifolia* Poiret ssp. *alba* (Miller) Greuter & Burdet	L	B	T	W	C	N
		Stellaria crassifolia Ehrh.	.	.	.	W	.	.
		Stellaria longifolia Muhlenb. ex Willd.	.	B	.	W	C	N
	*	*Stellaria media* (L.) Villars	.	.	.	.	C	.
CELASTRACEAE								
		Celastrus scandens L.	L	B	.	.	C	N
		Euonymus atropurpureus Jacq.	.	B	.	.	.	.
CERATOPHYLLACEAE								
		Ceratophyllum demersum L.	.	B	T	W	C	N
CHENOPODIACEAE								
		Atriplex patula L.	L	B	T	W	C	.
	*	*Chenopodium album* L.	L	B	T	W	C	N
		Chenopodium botrys L.	.	.	.	.	C	.
		Chenopodium desiccatum Nelson	L	B	T	.	C	N
	*	*Chenopodium glaucum* L.	L	B	T	W	C	N
		Chenopodium rubrum L.	L	B	T	W	C	N

		L	B	T	W	C	N
	Chenopodium simplex (Torrey) Raf.	L	B	T	W	C	N
	Chenopodium standleyanum Aellen	L	B	T	W	C	N
	Corispermum hyssopifolium L.	.	.	.	.	C	N
	Corispermum nitidum Kit. ex Schultes	.	.	.	.	C	.
*	*Corispermum orientale* Lam.[1]	.	.	.	.	C	.
	Cycloloma atriplicifolium (Sprengel) J. Coulter	.	.	.	.	C	N
*	*Kochia scoparia* (L.) Schrader	L	B	T	W	C	N
U	*Monolepis nuttalliana* (Roemer & Schultes) E. Greene	.	.	.	.	C	.
T	*Salicornia rubra* Nelson	L	.	.	.	.	.
*	*Salsola collina* Pallas	.	B	.	.	C	.
*	*Salsola iberica* Sennen & Pau	L	B	T	W	C	N
	Suaeda calceoliformis (Hook.) Moq.	L	.	.	W	C	.
CISTACEAE							
	Helianthemum bicknellii Fern.	.	.	.	.	C	N
	Lechea intermedia Legg.	.	.	.	.	.	N
	Lechea stricta Legg.	.	.	.	.	C	.
COMMELINACEAE							
	Tradescantia bracteata Small	.	B	.	W	C	N
	Tradescantia occidentalis (Britton) Smyth	.	.	.	.	C	N
CONVOLVULACEAE							
*	*Convolvulus arvensis* L.	L	.	T	W	C	N
	Convolvulus sepium L.	L	B	T	W	C	N
	Cuscuta campestris Yuncker[1]	.	.	.	.	C	.
	Cuscuta cephalanthi Engelm.	L	.	.	.	.	.
	Cuscuta coryli Engelm.	.	.	.	.	C	.
	Cuscuta glomerata Choisy	.	B	.	.	.	.
	Cuscuta gronovii Willd.	.	B	.	.	C	.
	Cuscuta pentagona Engelm.	.	B	T	.	C	.
CORNACEAE							
	Cornus alternifolia L.f.	.	.	.	.	C	N
	Cornus foemina Miller						
	ssp. *racemosa* (Lam.) J. S. Wilson	.	.	.	.	C	N
†	*Cornus rugosa* Lam.	.	.	.	.	C	.
	Cornus stolonifera Michaux	L	B	T	W	C	N
CRASSULACEAE							
	Penthorum sedoides L.	L	B	T	W	C	N
CUCURBITACEAE							
	Echinocystis lobata (Michaux) Torrey & A. Gray	L	B	T	W	C	N
	Sicyos angulatus L.	.	B	.	.	.	.
CYPERACEAE							
†	*Carex abdita* Bickn.	.	B	T	W	C	N
	Carex alopecoidea Tuckerman	L	B	T	W	C	N
	Carex amphibola Steudel var. *turgida* Fern.	L	.	.	.	.	.
	Carex aquatilis Wahlenb. var. *altior* (Rydb.) Fern.	.	.	.	W	C	N
	Carex assiniboinensis W. Boott	L	B	T	W	C	N
	Carex atherodes Sprengel	L	B	T	W	C	N
	Carex aurea Nutt.	.	.	.	.	C	N
	Carex backii Boott	.	.	.	.	C	.
	Carex bebbii (L. Bailey) Fern.	.	.	.	.	C	N
	Carex bicknellii Britton	L	.	T	.	C	N
	Carex blanda Dewey	L	B	T	W	C	N
	Carex brevior (Dewey) Mackenzie	L	B	T	W	C	N
	Carex buxbaumii Wahlenb.	.	.	.	W	C	N
† U	*Carex capillaris* L. var. *major* Drejer	.	.	.	.	.	N
†	*Carex comosa* Boott	.	.	.	.	.	N

†	U	*Carex conoidea* Schkuhr ex Willd.	.	.	.	.	.	N
†		*Carex convoluta* Mackenzie	.	.	.	.	C	.
		Carex crawei Dewey	.	.	.	W	C	N
		Carex cristatella Britton	L	B	T	W	C	N
		Carex deweyana Schwein.	.	.	.	.	C	N
†		*Carex disperma* Dewey	.	.	.	.	C	N
		Carex eburnea Boott	.	.	T	.	C	N
		Carex eleocharis L. Bailey	L	B	T	.	C	.
		Carex emoryi Dewey	L	B	T	W	C	N
		Carex filifolia Nutt.	L	B	T	.	C	N
		Carex foenea Willd.	.	.	.	.	C	N
†		*Carex gracillima* Schwein.	.	.	.	.	.	N
		Carex granularis Muhlenb. ex Willd. var. *haleana* (Olney) Porter	.	.	T	.	C	N
		Carex gravida L. Bailey	L	B	T	W	C	N
	T	*Carex hallii* Olney	L	.	.	W	C	.
		Carex haydenii Dewey	.	.	.	.	.	N
		Carex heliophila Mackenzie	.	B	T	.	C	N
		Carex hystericina Muhlenb. ex Willd.	.	B	T	.	C	N
		Carex interior L. Bailey	L	.	.	W	C	N
†		*Carex intumescens* Rudge var. *fernaldii* L. Bailey	.	.	.	.	C	N
		Carex lacustris Willd.	.	.	.	W	C	N
		Carex laeviconica Dewey	.	.	.	W	C	N
		Carex lanuginosa Michaux	L	B	T	W	C	N
†		*Carex lasiocarpa* Ehrh. var. *americana* Fern.	.	.	.	.	.	N
†		*Carex leptalea* Wahlenb.	.	.	.	.	C	N
		Carex limosa L.	.	.	.	.	C	N
		Carex meadii Dewey	.	.	.	.	C	N
		Carex molesta Mackenzie ex Bright	L	.	.	.	.	.
	C	*Carex obtusata* Lilj.	.	.	.	.	C	.
		Carex peckii Howe	L	B	T	.	C	N
		Carex pedunculata Muhlenb. ex Willd.	.	.	.	.	C	N
		Carex pensylvanica Lam.	L	B	.	.	C	N
		Carex praegracilis W. Boott	L	B	T	W	C	N
		Carex prairea Dewey	.	.	.	.	C	N
†		*Carex pseudocyperus* L.	.	.	.	.	C	.
		Carex retrorsa Schwein.	L	B	.	W	C	N
		Carex richardsonii R. Br.	L	.	.	.	.	N
		Carex rosea Schk. ex Willd.	.	.	.	.	C	N
		Carex rostrata Stokes var. *utriculata* (Boott) L. Bailey	.	.	.	.	C	N
		Carex sartwellii Dewey	L	.	.	W	C	N
		Carex saximontana Mackenzie	.	B	T	.	C	N
	C	*Carex scirpiformis* Mackenzie	.	.	.	W	C	N
		Carex sprengelii Sprengel	.	B	T	W	C	N
	T	*Carex sterilis* Willd.	.	.	.	W	C	N
		Carex stipata Muhlenb. ex Willd.	.	.	.	.	C	N
		Carex stricta Lam.	L	.	.	.	C	N
		Carex sychnocephala Carey	L	B	T	W	C	N
		Carex tenera Dewey	L	B	T	W	C	N
		Carex tetanica Schkuhr	.	.	.	W	C	N
		Carex torreyi Tuckerman	.	.	.	.	C	.
†		*Carex tuckermanii* Dewey	.	.	.	.	C	.
†		*Carex vesicaria* L.	.	.	.	.	.	N
		Carex viridula Michaux	.	.	.	W	C	N
		Carex vulpinoidea Michaux	L	B	T	W	C	N
†	PE	*Carex xerantica* L. Bailey	.	.	.	.	C	.
†	C	*Cladium mariscoides* (Muhlenb.) Torrey	.	.	.	.	.	N

†	C	*Cyperus acuminatus* Torrey & Hook.	.	B	T	.	.	.
		Cyperus aristatus Rottb.	L	B	T	.	C	N
		Cyperus diandrus Torrey	.	B	.	.	.	.
		Cyperus engelmannii Steudel	L	B	T	.	.	.
		Cyperus erythrorhizos Muhlenb.	L	B	T	W	C	N
		Cyperus esculentus L.	.	.	.	.	C	N
		Cyperus odoratus L.	L	B	T	W	C	N
		Cyperus rivularis Kunth	.	.	.	.	C	N
		Cyperus schweinitzii Torrey	.	.	.	.	C	N
		Eleocharis acicularis (L.) Roemer & Schultes	L	B	T	W	C	N
		Eleocharis compressa Sulliv.	.	.	.	W	C	N
		Eleocharis engelmannii Steudel	.	B	.	W	C	.
		Eleocharis erythropoda Steudel	L	B	T	W	C	N
		Eleocharis intermedia Schultes	.	.	.	.	.	N
		Eleocharis macrostachya Britton	.	B	.	.	C	.
		Eleocharis obtusa (Willd.) Schultes	L	B	.	.	C	N
	PT	*Eleocharis parvula* (Roemer & Schultes) Link var. *anachaeta* (Torrey) Svenson	.	B	.	.	.	.
	C	*Eleocharis pauciflora* (Light.) Link var. *fernaldii* Svenson	.	.	.	W	.	N
†	T	*Eleocharis rostellata* Torrey	.	.	.	.	.	N
		Eleocharis smallii Britton	.	B	.	.	C	N
		Eleocharis wolfii A. Gray	.	.	T	.	.	N
		Eriophorum angustifolium Honck.	.	.	.	W	C	N
		Eriophorum viridi-carinatum (Engelm.) Fern.	.	.	.	.	C	.
†		*Fimbristylis puberula* (Michaux) Vahl var. *interior* (Britton) Kral	.	.	.	W	.	.
	T	*Rhynchospora capillacea* Torrey	.	.	.	W	C	N
		Scirpus acutus Bigelow	L	B	T	W	C	N
		Scirpus atrocinctus Fern.	.	.	.	.	.	N
		Scirpus atrovirens Willd.	.	.	.	.	.	N
		Scirpus cespitosus L. var. *callosus* Bigelow	.	.	.	.	C	N
		Scirpus cyperinus (L.) Kunth	.	.	.	.	C	N
		Scirpus fluviatilis (Torrey) A. Gray	L	B	T	.	C	.
		Scirpus heterochaetus Chase	L	.	.	.	.	.
		Scirpus microcarpus C. Presl	.	.	.	.	C	N
		Scirpus pallidus (Britton) Fern.	L	B	T	W	C	N
		Scirpus paludosus Nelson	L	B	T	W	C	N
		Scirpus pungens Vahl	L	B	T	W	C	N
		Scirpus validus Vahl var. *creber* Fern.	L	B	T	W	C	N
	T	*Scleria verticillata* Muhlenb.	.	.	.	W	C	N
DIPSACACEAE								
	*	*Knautia arvensis* (L.) J. Coulter	.	.	.	.	C	.
DROSERACEAE								
†		*Drosera rotundifolia* L.	.	.	.	.	.	N
ELAEAGNACEAE								
	*	*Elaeagnus angustifolia* L.	L	B	T	.	C	.
		Elaeagnus commutata Bernh.	L	.	T	W	C	N
		Shepherdia argentea Nutt.	.	.	T	.	C	N
ELATINACEAE								
	U	*Elatine triandra* Schkuhr	L	B	.	.	.	.
ERICACEAE								
		Arctostaphylos uva-ursi (L.) Sprengel	.	.	.	.	.	N
EUPHORBIACEAE								
	*	*Euphorbia cyparissias* L.	.	.	.	W	C	.

†		*Euphorbia geyeri* Engelm.	.	.	.	.	.	N
		Euphorbia glyptosperma Engelm.	L	B	T	W	C	N
		Euphorbia maculata L.	L	B	T	W	C	N
		Euphorbia marginata Pursh	L	.	.	.	.	.
		Euphorbia nutans Lagasca	.	B	.	.	.	.
		Euphorbia podperae Croizat	L	B	.	W	C	N.
		Euphorbia serpyllifolia Pers.	L	B	T	W	C	N
FABACEAE								
		Amorpha canescens Pursh	L	B	T	W	C	N
		Amorpha fruticosa L.	L	B	T	W	C	N
		Amorpha nana Nutt.	L	B	T	W	C	N
		Amphicarpaea bracteata (L.) Fern.	L	B	T	W	C	N
		Apios americana Medikus	.	B	.	.	.	.
		Astragalus adsurgens Pallas var. *robustior* Hook.	L	.	.	.	C	N
		Astragalus agrestis Douglas ex G. Don	L	B	T	W	C	N
		Astragalus canadensis L.	L	B	T	W	C	N
		Astragalus crassicarpus Nutt.	L	B	T	W	C	N
	C	*Astragalus flexuosus* (Hook.) G. Don	L	B	T	.	.	.
	U	*Astragalus lotiflorus* Hook.	L	B	T	.	C	N
	C	*Astragalus missouriensis* Nutt.	L	B	T	.	.	.
	*	*Coronilla varia* L.	.	.	.	.	.	N
		Dalea leporina (Aiton) Bullock	L	B	T	.	.	.
	C	*Desmanthus illinoensis* (Michaux) MacMillan	.	B	T	.	.	.
		Desmodium canadense (L.) DC.	.	B	.	.	C	N
†		*Desmodium glutinosum* (Muhlenb. ex Willd.) A. Wood	.	.	.	.	C	N
		Glycyrrhiza lepidota Pursh	L	B	T	W	C	N
		Lathyrus ochroleucus Hook.	.	.	.	.	C	N
		Lathyrus palustris L.	L	.	T	W	C	N
		Lathyrus venosus Muhlenb. ex Willd. var. *intonsus* Butters & H. St. John	L	.	T	W	C	N
	*	*Lotus corniculatus* L.	L	B	T	W	C	N
		Lotus purshianus (Benth.) Clements & E. G. Clements	.	B	T	.	C	.
	*	*Medicago lupulina* L.	L	B	T	W	C	N
	*	*Medicago sativa* L.	L	B	T	W	C	N
	*	*Melilotus alba* Medikus	L	B	T	W	C	N
	*	*Melilotus officinalis* (L.) Pallas	L	B	T	W	C	N
		Oxytropis lambertii Pursh	L	B	T	.	C	N
		Petalostemon candidum (Willd.) Michaux	L	B	T	W	C	N
		Petalostemon occidentale (A. A. Heller) Fern.	L	B	T	.	.	.
		Petalostemon purpureum (Vent.) Rydb.	L	B	T	W	C	N
		Petalostemon villosum Nutt.	.	.	.	.	C	N
		Psoralea argophylla Pursh	L	B	T	W	C	N
		Psoralea esculenta Pursh	L	B	T	W	C	N
†		*Robinia pseudoacacia* L.	L	.	.	.	.	.
		Strophostyles helvola (L.) Elliott	L	.	.	.	.	.
	*	*Trifolium hybridum* L.	.	.	.	W	C	.
	*	*Trifolium pratense* L.	L	B	T	W	C	N
	*	*Trifolium repens* L.	L	B	T	W	C	N
		Vicia americana Muhlenb. ex Willd.	L	B	T	W	C	N
	*	*Vicia angustifolia* (L.) Reichard	.	.	.	.	C	.
FAGACEAE								
		Quercus macrocarpa Michaux	L	B	T	W	C	N
		Quercus rubra L.	.	.	.	.	C	.
FUMARIACEAE								
		Corydalis aurea Willd.	.	.	.	.	C	N
		Dicentra cucullaria (L.) Bernh.	.	B	.	.	.	.

GENTIANACEAE								
	C	*Gentiana affinis* Griseb.	.	.	.	W	C	N
		Gentiana andrewsii Griseb.	L	B	T	W	C	N
		Gentiana puberulenta J. Pringle	L	.	T	W	C	N
	C	*Gentianella amarella* (L.) Borner ssp. *acuta* (Michaux) J. M. Gillett	.	.	.	.	C	.
		Gentianopsis procera (Holm) Ma	L	.	.	W	C	N
GERANIACEAE								
	†	*Geranium bicknellii* Britton	.	.	.	.	.	N
		Geranium carolinianum L.	L	B	.	.	C	.
		Geranium maculatum L.	.	.	.	.	C	.
HALORAGACEAE								
		Myriophyllum sibiricum Komarov	.	B	.	.	C	.
HIPPURIDACEAE								
		Hippuris vulgaris L.	.	.	.	W	C	N
HYDROCHARITACEAE								
		Elodea nuttallii (Planchon) H. St. John	L	B	.	.	.	.
		Vallisneria americana Michaux	.	B	.	.	.	.
HYDROPHYLLACEAE								
		Ellisia nyctelea L.	L	B	T	W	C	N
		Hydrophyllum virginianum L.	L	B	T	W	C	N
HYPERICACEAE								
		Hypericum majus (A. Gray) Britton	.	.	.	.	.	N
IRIDACEAE								
	†	*Iris versicolor* L.	.	.	.	.	.	N
		Sisyrinchium campestre Bickn.	L	B	T	.	C	N
		Sisyrinchium montanum E. Greene	.	.	.	W	C	N
		Sisyrinchium mucronatum Michaux	.	.	.	W	C	N
JUNCACEAE								
		Juncus alpinoarticulatus Chaix	.	.	.	W	C	N
		Juncus balticus Willd. var. *littoralis* Engelm.	L	B	T	W	C	N
		Juncus brevicaudatus (Engelm.) Fern.	.	.	.	.	C	N
		Juncus bufonius L.	.	.	.	W	C	N
		Juncus dudleyi Wieg.	L	B	T	W	C	N
		Juncus interior Wieg.	L	.	.	W	.	N
		Juncus longistylis Torrey	.	.	.	.	C	N
		Juncus nodosus L.	.	.	.	W	C	N
		Juncus tenuis Willd.	L	.	.	.	.	.
		Juncus torreyi Cov.	L	B	T	W	C	N
	†	*Luzula multiflora* (Retz.) Lej.	.	.	.	.	.	N
JUNCAGINACEAE								
		Triglochin maritima L.	L	.	.	W	C	N
	C	*Triglochin palustris* L.	.	.	.	W	C	N
LAMIACEAE								
		Agastache foeniculum (Pursh) Kuntze	.	B	.	.	C	N
		Agastache scrophulariaefolia (Willd.) Kuntze	.	B	.	.	.	.
		Dracocephalum parviflorum Nutt.	.	B	.	.	C	N
	*	*Galeopsis tetrahit* L.	.	.	.	.	C	.
	*	*Glechoma hederacea* L.	L	B	T	W	C	N
		Hedeoma hispida Pursh	L	B	T	.	C	N
		Isanthus brachiatus (L.) B.S.P.	L	B	.	.	.	.
	*	*Leonurus cardiaca* L.	.	.	T	W	C	N
		Lycopus americanus Muhlenb.	L	B	T	W	C	N
		Lycopus asper E. Greene	L	B	T	W	C	N

		Lycopus uniflorus Michaux	.	.	.	W	C	N
		Mentha arvensis L. var. *glabrata* (Benth.) Fern.	L	B	T	W	C	N
		Monarda fistulosa L.	.	.	T	.	C	N
	*	*Nepeta cataria* L.	L	B	T	W	C	N
		Physostegia virginiana (L.) Benth.	.	.	.	W	C	N
		Prunella vulgaris L.	L	.	.	W	C	N
		Pycnanthemum virginianum (L.) T. Durand & B. D. Jackson	.	.	.	W	C	N
		Salvia reflexa Hornem.	L	B	T	.	C	.
		Scutellaria galericulata L.	L	.	.	W	C	N
		Scutellaria lateriflora L.	L	B	T	W	C	N
		Scutellaria leonardii Epling	.	B	.	W	C	.
		Stachys palustris L.	L	B	T	W	C	N
		Stachys tenuifolia Willd.	.	.	.	.	C	.
		Teucrium canadense L.	L	B	T	W	C	N
LEMNACEAE								
		Lemna minor L.	L	.	T	W	C	N
		Lemna trisulca L.	L	B	T	W	C	N
		Spirodela polyrhiza (L.) Schleiden	.	B	.	.	C	N
LENTIBULARIACEAE								
		Utricularia intermedia Hayne	.	.	.	.	C	N
		Utricularia minor L.	.	.	.	.	C	N
		Utricularia vulgaris L.	L	B	.	W	C	N
LILIACEAE								
		Allium canadense L.	.	B	.	.	C	.
		Allium stellatum Ker Gawler	L	B	T	W	C	N
		Allium textile Nelson & J. F. Macbr.	L	B	T	.	C	N
		Allium tricoccum Aiton	.	B	.	.	C	N
	*	*Asparagus officinalis* L.	L	B	T	W	C	N
		Erythronium albidum Nutt.	.	.	.	.	C	.
		Lilium philadelphicum L.	L	B	T	W	C	N
		Maianthemum canadense Desf.	L	.	T	.	C	N
		Polygonatum commutatum (Schultes f.) A. Dietr.	L	B	T	W	C	N
		Smilacina racemosa (L.) Desf.	.	.	.	.	C	N
		Smilacina stellata (L.) Desf.	L	B	T	W	C	N
†		*Smilax ecirrata* (Engelm.) S. Watson	.	.	.	.	C	.
		Smilax lasioneura Hook.	L	B	T	W	C	N
†		*Streptopus roseus* Michaux	.	.	.	.	.	N
	C	*Tofieldia glutinosa* (Michaux) Pers.	.	.	.	.	C	N
		Trillium cernuum L.	.	B	.	.	C	N
		Uvularia grandiflora Smith	.	.	.	.	C	N
		Uvularia sessilifolia L.	.	.	.	.	C	.
		Zigadenus elegans Pursh	L	B	T	W	C	N
LINACEAE								
		Linum rigidum Pursh	L	.	.	.	C	N
		Linum sulcatum Riddell	.	.	.	W	C	N
	*	*Linum usitatissimum* L.	L	.	.	W	C	.
LYTHRACEAE								
		Ammannia coccinea Rottb.	.	B	T	W	C	.
		Lythrum alatum Pursh	L	.	T	W	C	.
	PT	*Rotala ramosior* (L.) Koehne	L	.	.	.	.	.
MALVACEAE								
†	*	*Abutilon theophrasti* Medikus	.	B	.	.	.	N
	*	*Hibiscus trionum* L.	.	B	T	.	C	.
	*	*Malva neglecta* Wallr.	.	.	.	.	C	.

		L	B	T	W	C	N
*	*Malva rotundifolia* L.						
	Sphaeralcea coccinea (Pursh) Rydb.	L	.	.	.	.	.
MENISPERMACEAE							
	Menispermum canadense L.	L	B	T	W	C	N
MENYANTHACEAE							
	Menyanthes trifoliata L. var. *minor* Raf.	.	.	.	.	C	N
MONOTROPACEAE							
†	*Monotropa uniflora* L.	.	.	.	.	C	.
MORACEAE							
*	*Cannabis sativa* L.	L	B	.	.	.	.
	Humulus lupulus L.	.	B	T	.	C	.
*	*Morus alba* L.	.	B	.	.	.	.
NAJADACEAE							
	Najas flexilis (Willd.) Rostk. & Schmidt	.	B	.	.	C	.
	Najas guadalupensis (Sprengel) Magnus	L	B	.	.	.	.
	Najas marina L.	.	B	.	.	.	.
NYCTAGINACEAE							
	Mirabilis hirsuta (Pursh) MacMillan	L	B	T	W	C	N
	Mirabilis nyctaginea (Michaux) MacMillan	L	B	T	W	C	N
NYMPHAEACEAE							
†	*Nuphar luteum* (L.) Sibth. & Smith ssp. *variegatum* (Engelm. ex Clinton) E. Beal	.	.	.	.	C	N
OLEACEAE							
	Fraxinus nigra Marshall	.	.	.	.	C	N
	Fraxinus pennsylvanica Marshall	L	B	T	W	C	N
ONAGRACEAE							
	Calylophus serrulatus (Nutt.) Raven	L	B	T	W	C	N
	Circaea lutetiana L. ssp. *canadensis* (L.) Asch. & Magnus	.	B	T	.	C	N
	Epilobium coloratum Biehler	.	.	.	.	C	.
	Epilobium glandulosum Lehm.	L	B	T	.	C	N
	Epilobium leptophyllum Raf.	L	.	.	W	C	N
	Gaura coccinea Pursh	L	B	T	.	C	N
	Oenothera biennis L.	L	B	T	W	C	N
	Oenothera nuttallii Sweet	.	.	T	.	C	N
	Oenothera parviflora L.[1]	.	.	.	.	.	N
	Oenothera perennis L.	.	.	.	.	.	N
	Oenothera villosa Thunb.	.	.	.	W	C	.
ORCHIDACEAE							
	Cypripedium calceolus L. var. *parviflorum* (Salisb.) Fern.	.	.	.	.	C	N
	Cypripedium calceolus L. var. *pubescens* (Willd.) Correll	.	.	.	.	C	N
C	*Cypripedium candidum* Muhlenb. ex Willd.	L	B	.	W	C	N
	Cypripedium reginae Walter	.	.	.	.	.	N
	Liparis loeselii (L.) Rich.	.	.	.	.	C	N
	Platanthera hyperborea (L.) Lindley	.	.	.	W	C	N
E	*Platanthera praeclara* Sheviak & Bowles	.	.	.	.	C	.
	Spiranthes cernua (L.) Rich.	.	.	.	W	.	.
	Spiranthes magnicamporum Sheviak	L	.	T	.	C	N
	Spiranthes romanzoffianum Cham.	.	.	.	.	.	N
OROBANCHACEAE							
C	*Orobanche fasciculata* Nutt.	.	.	.	.	C	.
C	*Orobanche ludoviciana* Nutt.	L	.	.	.	C	.

OXALIDACEAE								
		Oxalis dillenii Jacq.	L	B	T	.	C	N
		Oxalis stricta L.	L	B	T	W	C	N
		Oxalis violacea L.	L	B	T	W	C	N
PAPAVERACEAE								
		Sanguinaria canadensis L.	L	.	.	.	C	N
PHRYMACEAE								
		Phryma leptostachya L.	L	B	T	W	C	N
PLANTAGINACEAE								
		Plantago eriopoda Torrey	L	.	.	W	C	.
	*	*Plantago major* L.	L	B	T	W	C	N
		Plantago patagonica Jacq.	L	B	.	.	C	.
	*	*Plantago psyllium* L.	.	.	.	.	C	.
		Plantago rugelii Decne.	L	.	T	.	C	N
POACEAE								
		×*Agrohordeum macounii* (Vasey) Lepage	.	.	.	W	C	.
	*	*Agropyron pectiniforme* Roemer & Schultes	.	B	T	W	C	.
		Agropyron repens (L.) Beauv.	L	B	T	W	C	N
		Agropyron smithii Rydb.	.	.	.	W	C	.
		Agropyron trachycaulum (Link) Malte	L	B	T	W	C	N
		Agrostis hyemalis (Walter) B.S.P.	.	.	.	.	.	N
†		*Agrostis perennans* (Walter) Tuckerman	.	.	.	W	.	.
		Agrostis scabra Willd.	L	.	T	W	C	N
	*	*Agrostis stolonifera* L.						
		var. *major* (Gaudich.) Farw.	L	B	.	W	C	N
		var. *palustris* (Hudson) Farw.	.	.	.	.	C	N
		Alopecurus aequalis Sobol.	.	.	.	W	C	N
	U	*Alopecurus carolinianus* Walter	L	B	.	.	C	.
		Andropogon gerardii Vitman	L	B	T	W	C	N
		Aristida dichotoma Michaux var. *curtissii* A. Gray	L	B	.	.	.	.
	C	*Aristida purpurea* Nutt. var. *longiseta* (Steudel) Vasey	L	B	T	.	C	.
	*	*Avena fatua* L.	.	.	.	W	C	N
	*	*Avena sativa* L.	.	.	.	.	C	.
		Beckmannia syzigachne (Steudel) Fern.						
		var. *baicalensis* (Kush.) T. Koyama & Kawano	L	B	T	W	C	N
		Bouteloua curtipendula (Michaux) Torrey	L	B	T	W	C	N
		Bouteloua gracilis (H.B.K.) Lagasca ex Steudel	L	B	T	.	C	N
		Bouteloua hirsuta Lagasca	L	B	T	.	C	N
		Bromus ciliatus L.	.	.	.	W	C	N
	*	*Bromus inermis* Leysser	L	B	T	W	C	N
	*	*Bromus japonicus* Thunb. ex Murray	.	B	T	.	C	.
		Bromus kalmii A. Gray	.	.	.	.	C	N
		Bromus latiglumis (Shear) A. Hitchc.	L	B	T	W	C	N
		Bromus pubescens Muhlenb. ex Willd.	.	.	.	.	C	N
	*	*Bromus tectorum* L.	.	B	.	.	C	.
	C	*Buchloë dactyloides* (Nutt.) Engelm.	L	.	.	.	.	.
		Calamagrostis canadensis (Michaux) Beauv.	.	.	.	W	C	N
		Calamagrostis inexpansa A. Gray						
		var. *brevior* (Vasey) Stebbins	L	.	.	W	C	N
	U	*Calamagrostis montanensis* Scribner	.	.	T	.	C	N
		Calamovilfa longifolia (Hook.) Scribner	L	B	.	.	C	N
		Cenchrus longispinus (Hackel) Fern.	.	.	.	.	C	N
†	*	*Dactylis glomerata* L.	.	.	.	.	.	N
		Danthonia spicata (L.) Beauv. ex Roemer & Schultes	.	.	.	.	.	N
		Deschampsia cespitosa (L.) Beauv.						
		var. *glauca* (Hartman) Lindman	.	.	.	.	C	N

	*	*Digitaria ischaemum* (Schreber) Muhlenb.	.	.	.	W	C	.
	*	*Digitaria sanguinalis* (L.) Scop.	L	B	.	.	.	.
		Diplachne fascicularis (Lam.) Beauv.	.	B	.	W	C	.
		Distichlis stricta (Torrey) Rydb.	L	B	T	W	C	N
	*	*Echinochloa crusgalli* (L.) Beauv.	L	B	T	W	C	N
		Echinochloa muricata (Beauv.) Fern.	.	B	T	W	C	N
		Elymus canadensis L.	.	B	T	W	C	N
		Elymus diversiglumis Scribner & C. Ball	.	.	.	.	C	.
		Elymus hystrix L.	L	.	T	.	C	N
		Elymus villosus Muhlenb. ex Willd.	L	B	T	.	C	N
		Elymus virginicus L.	L	B	T	W	C	N
		Elymus wiegandii Fern.	.	.	.	.	C	.
	*	*Eragrostis cilianensis* (All.) Latati ex Hubbard	L	B	T	W	C	N
		Eragrostis hypnoides (Lam.) B.S.P.	L	B	T	W	C	N
†	*	*Eragrostis minor* Host	.	.	T	.	C	.
		Eragrostis pectinacea (Michaux) Nees	L	B	T	W	C	N
		Eragrostis spectabilis (Pursh) Steudel	.	.	.	.	C	N
		Festuca obtusa Biehler	L	B	T	.	C	N
		Festuca ovina L.	.	.	.	.	C	.
	*	*Festuca pratensis* Hudson	.	.	.	W	C	.
		Glyceria borealis (Nash) Batch.	.	.	.	.	C	.
		Glyceria grandis S. Wats.	.	.	.	W	C	N
		Glyceria striata (Lam.) A. Hitchc.	L	B	T	W	C	N
		Helictotrichon hookeri (Scribner) Henrard	.	.	.	.	C	N
		Hierochloë odorata (L.) Beauv. ssp. *hirta* (Schrank) Tzvelev	L	.	.	W	C	N
		Hordeum jubatum L.	L	B	T	W	C	N
	U	*Hordeum pusillum* Nutt.	L	.	.	.	.	.
		Koeleria macrantha (Ledeb.) Schultes	L	B	T	W	C	N
		Leersia oryzoides (L.) Sw.	L	B	T	W	C	N
		Leersia virginica Willd.	L	B	.	.	.	.
	*	*Lolium perenne* L.	.	.	.	W	.	N
		Muhlenbergia asperifolia (Nees & Meyen) Parodi	L	.	T	W	C	.
		Muhlenbergia cuspidata (Torrey) Rydb.	L	B	T	.	C	N
		Muhlenbergia frondosa (Poiret) Fern.	L	B	T	W	C	N
		Muhlenbergia glomerata (Willd.) Trin.	.	.	.	W	C	N
		Muhlenbergia mexicana (L.) Trin.	L	B	.	W	C	N
		Muhlenbergia racemosa (Michaux) B.S.P.	L	B	T	W	C	N
		Muhlenbergia richardsonis (Trin.) Rydb.	L	.	T	W	C	N
		Oryzopsis asperifolia Michaux	.	.	.	.	C	N
	E	*Oryzopsis hymenoides* (Roemer & Schultes) Ricker	.	.	.	.	.	N
		Oryzopsis racemosa (Smith) Ricker	.	B	.	.	C	N
		Panicum capillare L.	L	B	T	W	C	N
		Panicum lanuginosum Elliott var. *fasciculatum* (Torrey) Fern.	.	B	.	W	C	.
		var. *implicatum* (Scribner) Fern.	.	B	.	W	C	N
		Panicum leibergii (Vasey) Scribner	L	B	T	W	C	N
		Panicum linearifolium Scribner	.	.	.	.	C	N
		Panicum meridionale Ashe[1]	L	B	.	.	C	.
		Panicum oligosanthes Schultes	L	.	.	.	C	N
		Panicum perlongum Nash	.	.	.	.	C	N
		Panicum virgatum L.	L	B	T	W	C	N
		Panicum wilcoxianum Vasey	.	B	.	.	C	N
		Phalaris arundinacea L.	L	B	T	W	C	N
	*	*Phleum pratense* L.	L	B	T	W	C	N
		Phragmites australis (Cav.) Steudel	L	B	T	W	C	N
	*	*Poa annua* L.	.	.	.	.	C	N

	U	*Poa arida* Vasey	.	.	.	W	C	.
	*	*Poa compressa* L.	L	.	.	W	C	N
		Poa palustris L.	.	.	.	W	C	.
	*	*Poa pratensis* L.	L	B	T	W	C	N
	U	*Puccinellia nuttalliana* (Schultes) A. Hitchc.	L	.	.	W	C	.
	C	*Schedonnardus paniculatus* (Nutt.) Trel.	L	.	.	.	.	.
		Schizachne purpurascens (Torrey) Swallen	.	.	.	.	C	N
		Schizachyrium scoparium (Michaux) Nash	L	B	T	W	C	N
		Scolochloa festucacea (Willd.) Link	.	.	.	.	C	.
	*	*Secale cereale* L.	.	.	.	W	C	N
	*	*Setaria glauca* (L.) Beauv.	L	B	T	W	C	N
†	*	*Setaria italica* (L.) Beauv.	.	B	.	.	.	.
	*	*Setaria verticillata* (L.) Beauv.	.	.	.	.	C	.
	*	*Setaria viridis* (L.) Beauv.	L	B	T	W	C	N
		Sorghastrum nutans (L.) Nash	L	B	T	W	C	N
	C	*Spartina gracilis* Trin.	.	.	.	W	C	N
		Spartina pectinata Link	L	B	T	W	C	N
		Sphenopholis intermedia Rydb.	.	.	.	W	C	.
		Sphenopholis obtusata (Michaux) Scribner	.	.	.	W	C	.
		Sporobolus asper (Michaux) Kunth	L	B	T	W	C	.
		Sporobolus cryptandrus (Torrey) A. Gray	.	.	.	.	C	N
		Sporobolus heterolepis (A. Gray) A. Gray	L	B	T	W	C	N
		Sporobolus neglectus Nash	L	B	.	.	C	N
		Sporobolus vaginiflorus (Torrey) A. Wood	L	B	.	.	.	.
		Stipa comata Trin. & Rupr.	L	B	T	.	C	N
		Stipa spartea Trin.	L	B	.	W	C	N
		Stipa viridula Trin.	L	B	T	.	C	.
	C	*Triplasis purpurea* (Walter) Chapman	.	.	.	.	.	N
		Vulpia octoflora (Walter) Rydb. var. *glauca* (Nutt.) Fern.	.	.	.	.	C	.
		Zizania palustris L.	L	.	.	.	C	N
POLEMONIACEAE								
		Collomia linearis Nutt.	L	B	.	.	C	.
		Phlox divaricata L. ssp. *laphamii* (A. Wood) Wherry	L	.	.	.	.	.
		Phlox pilosa L. ssp. *fulgida* (Wherry) Wherry	.	.	.	W	C	N
POLYGALACEAE								
		Polygala senega L.	.	.	.	W	C	N
		Polygala verticillata L. var. *isocycla* Fern.	L	.	T	W	C	.
POLYGONACEAE								
	*	*Fagopyrum esculentum* Moench	.	.	.	.	C	.
		Polygonum achoreum Blake	L	B	T	W	C	.
†		*Polygonum amphibium* L. var. *stipulaceum* Coleman	L	B	T	W	C	N
	*	*Polygonum arenastrum* Boreau	L	B	T	W	C	.
		Polygonum coccineum Muhlenb.	L	B	T	W	C	N
		Polygonum convolvulus L.	L	B	T	W	C	N
		Polygonum hydropiper L.	.	B	.	.	C	N
		Polygonum lapathifolium L.	L	B	T	W	C	N
		Polygonum pensylvanicum L.	L	B	T	.	C	N
	*	*Polygonum persicaria* L.	.	B	T	.	C	.
		Polygonum punctatum Elliott	.	.	.	.	C	N
		Polygonum ramosissimum Michaux	L	B	T	W	C	N
		Polygonum sagittatum L.	L	.	.	.	.	.
		Polygonum tenue Michaux	L	B	.	.	.	.
	*	*Rumex acetosella* L.	.	.	T	.	.	.
†		*Rumex altissimus* A. Wood	.	.	T	.	.	.
	*	*Rumex crispus* L.	.	.	.	W	.	N

*	*Rumex longifolius* DC.	.	.	.	W	C	.
	Rumex maritimus L. var. *fueginus* (Philippi) Dusén	L	B	T	W	C	N
	Rumex mexicanus Meissner	L	B	T	W	C	N
	Rumex orbiculatus A. Gray	.	.	.	.	C	N
	Rumex stenophyllus Ledeb.	L	B	T	W	C	N
PONTEDERIACEAE							
	Heteranthera dubia (Jacq.) MacMillan	.	B	T	.	C	.
PORTULACACEAE							
*	*Portulaca oleracea* L.	L	B	T	W	C	N
	Talinum parviflorum Nutt.	L	B	.	.	.	.
POTAMOGETONACEAE							
	Potamogeton amplifolius Tuckerman	.	B	.	.	C	.
	Potamogeton foliosus Raf.	L	B	.	.	C	N
	Potamogeton gramineus L.	.	.	.	.	C	.
	Potamogeton natans L.	.	.	.	.	C	N
	Potamogeton nodosus Poiret	.	B	.	.	C	N
	Potamogeton pectinatus L.	L	B	T	W	C	N
	Potamogeton pusillus L. var. *pusillus*	.	.	.	.	C	.
	Potamogeton richardsonii (A. Bennett) Rydb.	.	B	.	.	C	N
	Potamogeton strictifolius A. Bennett	.	.	.	.	C	.
	Potamogeton zosteriformis Fern.	.	.	.	.	C	.
PRIMULACEAE							
	Androsace occidentalis Pursh	L	B	T	.	C	N
	Lysimachia ciliata L.	.	.	.	W	C	N
	Lysimachia hybrida Michaux	L	B	.	W	C	.
	Lysimachia quadriflora Sims	.	.	.	.	C	N
	Lysimachia thyrsiflora L.	.	.	.	W	C	N
	Primula mistassinica Michaux	.	.	.	.	.	N
†	*Trientalis borealis* Raf.	.	.	.	.	.	N
PYROLACEAE							
	Pyrola elliptica Nutt.	.	.	.	.	.	N
	Pyrola secunda L.	.	.	.	.	C	N
RANUNCULACEAE							
	Actaea rubra (Aiton) Willd.	L	B	T	W	C	N
	Anemone canadensis L.	L	B	T	W	C	N
	Anemone cylindrica A. Gray	L	B	T	W	C	N
	Anemone quinquefolia L. var. *bifolia* Farw.	.	.	.	.	C	N
	Anemone riparia Fern.	.	.	.	W	C	.
	Anemone virginiana L.	.	B	.	.	C	N
	Aquilegia canadensis L.	.	B	T	W	C	N
	Caltha palustris L.	.	.	T	W	C	N
	Clematis virginiana L.	L	B	.	.	C	N
	Delphinium virescens Nutt.	L	.	.	W	C	N
	Hepatica americana (DC.) Ker Gawler	.	.	.	.	C	N
C	*Myosurus minimus* L.	L	B	.	.	.	.
	Pulsatilla nuttalliana (DC.) Bercht. & J.S. Presl	L	B	T	.	C	N
	Ranunculus abortivus L.	L	B	T	W	C	N
	Ranunculus aquatilis L. var. *capillaceus* (Thuill.) DC.[1]	.	.	.	.	C	.
	Ranunculus circinatus Sibth. var. *subrigidus* (Drew) L. Benson	.	.	.	.	C	.
	Ranunculus cymbalaria Pursh	L	.	T	W	C	N
	Ranunculus flabellaris Raf.	L	B	.	W	C	N
	Ranunculus gmelinii DC.	.	.	.	.	C	N
	Ranunculus hispidus Michaux var. *caricetorum* (E. Greene) T. Duncan	.	.	.	W	.	.

	Ranunculus longirostris Godron	.	B	.	.	C	N
	Ranunculus macounii Britton	.	.	.	W	C	N
	Ranunculus pensylvanicus L. f.	L	B	T	W	C	N
†	*Ranunculus recurvatus* Poiret	.	.	.	.	.	N
	Ranunculus rhomboideus Goldie	.	.	.	.	C	N
	Ranunculus sceleratus L.	L	B	T	W	C	N
	Thalictrum dasycarpum Fischer & Ave-Lall.	.	.	T	W	C	N
	Thalictrum dioicum L.	.	.	.	.	C	N
	Thalictrum venulosum Trel.	.	.	.	.	C	N
RHAMNACEAE							
	Rhamnus alnifolius L'Her.	.	.	.	.	.	N
*	*Rhamnus cathartica* L.	L	B	T	W	C	N
ROSACEAE							
	Agrimonia gryposepala Wallr.	.	.	.	.	C	N
	Agrimonia striata Michaux	.	.	.	.	C	.
	Amelanchier alnifolia Nutt.	.	.	T	.	C	N
	Amelanchier humilis Wieg.	L	.	.	.	C	N
C	*Chamaerhodos nuttallii* Picker.	.	.	.	.	C	N
	Crataegus chrysocarpa Ashe	.	.	.	.	C	N
	Crataegus faxoni Sarg. var. *faxoni*[1]	.	B	.	.	.	.
	Crataegus succulenta Schrader ex Link	.	.	.	.	C	N
	Fragaria vesca L. ssp. *americana* (Porter) Staudt	.	.	T	.	C	.
	Fragaria virginiana Duchesne	L	B	.	W	C	N
	Geum aleppicum Jacq. var. *strictum* (Aiton) Fern.	.	.	.	.	C	N
	Geum canadense Jacq.	L	B	T	W	C	N
	Geum triflorum Pursh	L	B	.	W	C	N
	Potentilla anserina L.	L	B	T	W	C	N
*	*Potentilla argentea* L.	.	.	.	.	C	N
	Potentilla arguta Pursh	L	B	T	W	C	N
	Potentilla bipinnatifida Douglas	.	.	.	.	C	.
	Potentilla finitima Kohli & Packer	.	.	.	.	C	.
	Potentilla fruticosa L.	.	.	.	.	.	N
	Potentilla norvegica L.	L	B	T	W	C	N
	Potentilla paradoxa Nutt.	.	B	.	W	C	.
	Potentilla pensylvanica L.	L	.	.	.	C	N
*	*Potentilla recta* L.	.	.	.	.	C	.
	Potentilla rivalis Nutt.	L	B	T	.	C	N
	Prunus americana Marshall	L	B	T	W	C	N
	Prunus pensylvanica L. f.	.	.	.	.	C	N
	Prunus pumila L.	.	B	.	.	C	N
	Prunus serotina Ehrh.	.	.	.	.	C	N
	Prunus virginiana L.	L	B	T	W	C	N
	Rosa arkansana Porter	L	B	T	W	C	N
	Rosa blanda Aiton	L	B	T	W	C	N
	Rosa macounii E. Greene	L	B	.	W	.	N
	Rubus flagellaris Willd.	.	.	.	.	.	N
	Rubus occidentalis L.	.	B	T	.	.	N
	Rubus pubescens Raf.	.	.	.	.	C	N
	Rubus strigosus Michaux	L	B	T	.	C	N
	Spiraea alba Duroi	L	.	.	W	C	N
RUBIACEAE							
	Galium aparine L.	L	.	T	W	C	N
	Galium boreale L. ssp. *septentrionale* (Roemer & Schultes) Iltis	L	B	T	W	C	N
	Galium labradoricum (Wieg.) Wieg.	.	.	.	W	C	N
	Galium tinctorium L.	.	.	.	.	C	N

		Galium trifidum L.	.	.	.	W	C	N
		Galium triflorum Michaux	L	B	T	W	C	N
	*	*Galium verum* L.	L	.	.	.	.	.
		Hedyotis longifolia (Gaertner) Hook.	L	B	.	.	.	.
RUPPIACEAE								
		Ruppia occidentalis S. Wats.	.	B	.	.	.	.
RUTACEAE								
		Zanthoxylum americanum Miller	L	B	T	W	C	N
SALICACEAE								
		Populus balsamifera L.	.	.	.	W	C	N
		Populus deltoides Marshall ssp. *monilifera* (Aiton) Eckenw.	L	B	T	W	C	N
		Populus grandidentata Michaux	.	.	.	.	C	N
		Populus tremuloides Michaux	L	B	T	W	C	N
		Salix amygdaloides Andersson	L	B	T	W	C	N
		Salix bebbiana Sarg.	.	.	.	W	C	N
		Salix candida Fluegge	.	.	.	W	C	N
		Salix discolor Muhlenb.	.	.	.	W	C	N
		Salix eriocephala Michaux	.	.	.	W	C	N
		Salix exigua Nutt.	L	B	T	W	C	N
		Salix gracilis Andersson	.	.	.	W	C	N
		Salix humilis Marshall	.	.	.	.	C	N
		Salix lucida Muhlenb.	.	.	.	.	.	N
		Salix serissima (L. Bailey) Fern.	.	.	.	W	C	N
SANTALACEAE								
		Comandra umbellata (L.) Nutt.	L	B	T	W	C	N
SAXIFRAGACEAE								
		Heuchera richardsonii R. Br.	L	B	T	W	C	N
		Parnassia glauca Raf.	.	.	.	.	C	N
		Parnassia palustris L. var. *neogaea* Fern.	.	.	.	.	C	N
		Ribes americanum Miller	L	B	T	W	C	N
		Ribes cynosbati L.	.	B	.	.	C	N
†		*Ribes hirtellum* Michaux	.	.	.	.	.	N
†		*Ribes lacustre* (Pers.) Poiret	.	.	.	.	.	N
		Ribes missouriense Nutt.	L	B	T	W	C	N
		Ribes oxyacanthoides L.	.	.	.	.	C	.
		Ribes triste Pallas	.	.	.	.	C	N
SCROPHULARIACEAE								
		Agalinis aspera (Douglas ex Benth.) Britton	L	.	T	.	C	.
†	E	*Agalinis auriculata* (Michaux) Blake	.	B	.	.	.	.
†		*Agalinis paupercula* (A. Gray) Britton	.	.	.	W	.	N
		Agalinus tenuifolia (Vahl) Raf.	L	B	.	.	C	N
	C	*Bacopa rotundifolia* (Michaux) Wettst.	L	.	T	W	.	.
		Castilleja coccinea (L.) Sprengel	.	.	.	.	C	N
		Castilleja sessiliflora Pursh	L	B	T	.	C	.
		Gratiola neglecta Torrey	.	.	.	W	C	N
	C	*Limosella aquatica* L.	L	B	.	.	.	.
	*	*Linaria vulgaris* Hill	.	.	.	.	C	.
		Lindernia anagallidea (Michaux) Pennell	.	.	.	W	C	.
		Mimulus glabratus H.B.K. var. *fremontii* (Benth.) A. L. Grant	.	B	.	.	.	.
		Mimulus ringens L.	L	B	T	W	C	N
		Orthocarpus luteus Nutt.	.	.	.	.	.	N
		Pedicularis canadensis L.	L	B	T	W	C	N
		Pedicularis lanceolata Michaux	.	.	.	W	C	N

		Penstemon albidus Nutt.	L	B	T	.	C	N
		Penstemon gracilis Nutt.	L	B	.	.	C	N
		Penstemon grandiflorus Nutt.	L	B	T	.	C	N
		Scrophularia lanceolata Pursh	L	B	T	W	C	N
	*	*Verbascum thapsus* L.	L	B	.	.	C	N
		Veronica catenata Pennell	.	.	.	W	C	N
		Veronica peregrina L.	.	B	.	W	C	.
		Veronica scutellata L.	.	.	.	.	C	.
		Veronicastrum virginicum (L.) Farw.	.	.	.	.	C	N
SOLANACEAE								
		Physalis heterophylla Nees	L	B	T	.	C	N
		Physalis virginiana Miller	L	B	.	W	C	N
†	*	*Solanum dulcamara* L.	.	B	.	.	.	.
		Solanum ptycanthum Dunal ex DC.	L	B	T	W	C	N
	*	*Solanum rostratum* Dunal	L	B	.	.	C	.
SPARGANIACEAE								
		Sparganium chlorocarpum Rydb.	.	.	.	.	.	N
		Sparganium eurycarpum Engelm.	L	.	.	W	C	N
TILIACEAE								
		Tilia americana L.	L	B	T	W	C	N
TYPHACEAE								
		Typha angustifolia L.	L	B	T	W	C	N
		Typha latifolia L.	.	.	T	.	C	N
ULMACEAE								
		Celtis occidentalis L.	L	B	T	W	C	N
		Ulmus americana L.	L	B	T	W	C	N
†	*	*Ulmus pumila* L.	L	B	.	.	.	N
		Ulmus rubra Muhlenb. ex Willd.	.	B	.	.	C	N
		Ulmus thomasii Sarg.	.	.	.	W	.	.
URTICACEAE								
		Laportea canadensis (L.) Wedd.	L	B	T	W	C	N
		Parietaria pensylvanica Muhlenb. ex Willd	.	B	.	W	C	N
		Pilea fontana (Lunell) Rydb.	.	.	.	.	C	N
		Pilea pumila (L.) A. Gray	L	B	T	W	C	N
		Urtica dioica L. ssp. *gracilis* (Aiton) Selander	L	B	T	W	C	N
VERBENACEAE								
		Verbena bracteata Lagasca & Rodriguez	L	B	T	W	C	N
		Verbena hastata L.	L	B	T	W	C	N
		Verbena stricta Vent.	L	B	T	W	C	N
		Verbena urticifolia L.	L	B	T	W	C	N
VIOLACEAE								
		Viola canadensis L. var. *rugulosa* (E. Greene) C. Hitchc.	L	B	T	W	C	N
		Viola conspersa Reichenb.	.	.	.	.	C	N
		Viola missouriensis E. Greene	.	B	.	.	.	N
		Viola nephrophylla E. Greene	.	.	.	W	C	N
	C	*Viola nuttallii* Pursh	L	.	.	.	.	.
		Viola pedatifida G. Don	L	B	T	W	C	N
		Viola pratincola E. Greene	.	B	T	W	C	N
		Viola pubescens Aiton	.	B	.	W	C	N
		Viola sororia Willd.	.	B	.	.	C	N
VITACEAE								
		Parthenocissus inserta (A. Kerner) Fritsch	L	B	T	W	C	N
		Vitis riparia Michaux	L	B	T	W	C	N
ZANNICHELLIACEAE								
		Zannichellia palustris L. var. *major* (Boenn.) Koch	.	B	T	W	.	.

CHECKLIST OF MOSSES
(Western Minnesota)

AMBLYSTEGIACEAE
- *Amblystegium riparium* (Hedw.) BSG
+ + *Amblystegium serpens* (Hedw.) BSG var. *serpens*
+ + *Amblystegium tenax* (Hedw.) C. Jens.
- *Amblystegium trichopodium* (Schultz) Hartm.
+ + *Amblystegium varium* (Hedw.) Lindb.
+ + + *Campylium chrysophyllum* (Brid.) J. Lange
+ + *Campylium hispidulum* (Brid.) Mitt.
+ + + *Campylium stellatum* (Hedw.) C. Jens.
+ + *Drepanocladus aduncus* (Hedw.) Warnst.

ARCHIDIACEAE
- *Archidium ohioense* Schimp. ex C. M.

AULACOMNIACEAE
+ + *Aulacomnium palustre* (Hedw.) Schwaegr.

BARTRAMIACEAE
- *Bartramia pomiformis* Hedw.
- *Philonotis fontana* (Hedw.) Brid.

BRACHYTHECIACEAE
+ + *Brachythecium acuminatum* (Hedw.) Aust.
+ + *Brachythecium oxycladon* (Brid.) Jaeq. & Sauerb.
+ + *Brachythecium rivulare* BSG
+ + *Brachythecium rutabulum* (Hedw.) BSG
+ + + *Brachythecium salebrosum* (Web. & Mohr) BSG
+ + *Conardia compacta* (C.M.) Robins.
+ + *Eurhynchium pulchellum* (Hedw.) Jenn.
+ + + *Tomenthypnum nitens* (Hedw.) Loeske

BRYACEAE
+ + *Bryum algovicum* Sendtn. ex C. M.
+ + *Bryum argenteum* Hedw.
+ + + *Bryum caespiticium* Hedw.
- *Bryum capillare* Hedw.
+ + + *Bryum lisae* De Not var. *cuspidatum* (BSG) Marg.
- *Bryum pallescens* Schleich. ex Schwaegr.
+ + *Bryum pseudotriquetrum* (Hedw.) Gaertner, Meyer & Scherbius
+ + + *Bryum uliginosum* (Brid.) BSG
+ + *Leptobryum pyriforme* (Hedw.) Wils.
- *Pohlia cruda* (Hedw.) Lindb.
+ + *Pohlia nutans* (Hedw.) Lindb.
- *Pohlia wahlenbergii* (Web. & Mohr) Andr.
+ + *Rhodobryum roseum* (Hedw.) Limpr.

CLIMACIACEAE
- *Climacium dendroides* (Hedw.) Web. & Mohr

DICRANACEAE
+ + + *Dicranum polysetum* Sw.
- *Dicranum scoparium* Hedw.

DITRICHACEAE
+ + *Ceratodon purpureus* (Hedw.) Brid.
- *Pleuridium subulatum* (Hedw.) Rabh.
- *Saelania glaucescens* (Hedw.) Broth. ex Bom. & Broth.

ENCALYPTACEAE
Encalypta ciliata Hedw.
Encalypta rhaptocarpa Schwaegr.

ENTODONTACEAE
\+ *Entodon cladorrhizans* (Hedw.) C. M.
\+ *Entodon seductrix* (Hedw.) C. M.

FABRONIACEAE
Fabronia ciliaris (Brid.) Brid.

FISSIDENTACEAE
\+ *Fissidens fontanus* (B.-Pyl.) Steudel

FONTINALACEAE
Fontinalis hypnoides C. J. Hartm.

FUNARIACEAE
Funaria americana Lindb. ex Sull.
\+ *Funaria hygrometrica* Hedw.
Physcomitrium hookeri Hampe
\+ *Physcomitrium pyriforme* (Hedw.)
Pyramidula tetragona (Brid.) Brid.

GRIMMIACEAE
Grimmia apocarpa Hedw.
\+ *Grimmia laevigata* (Brid.) Brid.
Grimmia pilifera P.-Beauv.

HEDWIGIACEAE
\+ *Hedwigia ciliata* (Hedw.) P.-Beauv.

HYPNACEAE
\+ \+ *Callicladium haldanianum* (Grev.) Crum
Homomallium adnatum (Hedw.) Broth.
\+ \+ *Hypnum lindbergii* Mitt.
\+ \+ *Pylaisiella polyantha* (Hedw.) Grout
\+ \+ *Pylaisiella selwynii* (Kindb.) Crum, Steere & Anders.
Taxiphyllum deplanatum (Bruch & Schimp. ex Sull.) Fl.
\+ *Platygyrium repens* (Brid.) BSG

LESKEACEAE
\+ *Anomodon attenuatus* (Hedw.) Hueb.
\+ *Anomodon minor* (Hedw.) Fuernr.
\+ *Anomodon rostratus* (Hedw.) Schimp.
\+ \+ *Leskea gracilescens* Hedw.
Leskea obscura Hedw.
Leskea polycarpa Hedw.
\+ \+ *Leskeella nervosa* (Brid.) Loeske
\+ *Lindbergia brachyptera* (Mitt.) Kindb.

MNIACEAE
\+ *Mnium cuspidatum* Hedw.

ORTHOTRICHACEAE
Orthotrichum anomalum Hedw.
\+ \+ *Orthotrichum obtusifolium* Brid.
\+ \+ *Otrhotrichum ohioense* Sull. & Lesq. ex Aust.
\+ *Orthotrichum pumilum* Sw.
Orthotrichum strangulatum P.-Beauv.

PLAGIOTHECIACEAE
+ *Plagiothecium cavifolium* (Brid.) Iwats.

POLYTRICHACEAE
+ *Atrichum angustatum* (Brid.) BSG
Polytrichum commune Hedw.
Polytrichum juniperinum Hedw.
+ *Polytrichum piliferum* Hedw.

POTTIACEAE
Astomum muhlenbergianum (Sw.) Grout
Barbula fallax Hedw.
+ *Barbula unguiculata* Hedw.
+ *Bryoerythrophyllum recurvirostrum* (Hedw.) Chen
Didymodon tophaceus (Brid.) Lisa
Pterygoneurum subsessile (Brid.) Jur.
Tortula mucronifolia Schwaegr.
+ *Tortula ruralis* (Hedw.) Gaertn.

THUIDIACEAE
+ + *Haplocladium microphyllum* (Hedw.) Broth.
+ + *Helodium blandowii* (Web. & Mohr) Warnst.
Thuidium abietinum (Hedw.) BSG
+ *Thuidium delicatulum* (Hedw.) BSG
+ + *Thuidium recognitum* (Hewd.) Lindb.

TIMMIACEAE
+ *Timmia megapolitana* Hedw.

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REVIEWS

VASCULAR PLANTS OF MINNESOTA: A CHECKLIST AND ATLAS. By Gerald B. Ownbey & Thomas Morley. University of Minnesota Press, 2037 University Avenue S.E., Minneapolis, MN 55414. 1991. xi + 307 pp. $39.95 (cloth).

While botanists in Michigan are able to consult Ed Voss' volumes when they want information about many of the plants that occur in Michigan, our colleagues in Minnesota have not had a similar reference for their use. While certain areas of the state and plant groups had received detailed attention, the most recent statewide checklist prior to the present volume appeared in mimeographed form in 1946.

As the title implies, the book can be divided into two halves, a checklist and an atlas. A four page Introduction should be read by all users since both the scope and limitations of the volume are given, information that comes in very handy in explaining some, but not all, of the questions that may arise when using the text and maps.

The Checklist occupies the next 80 pages, including entries for 2,010 (1,618 native and 392 introduced) species. Plant families appear alphabetically within the Pteridophytes, Gymnosperms, and Angiosperms; the intermingling of monocots and dicots into a single alphabetical list is not usually seen and may bother some users. A typical family entry includes a common name, the range of map numbers for included taxa, and an alphabetical enumeration of included genera. A list of recent references sometimes precedes the first genus treatment. Within a genus, the common name, range of map numbers, and (sometimes) a similar reference list are followed by an alphabetical listing of species. "Checklist" is the appropriate word to describe the entries, since for many species the scientific name and a common name (where it "appear[s] well established by usage") is the only information provided. Pertinent synonyms are listed where appropriate. Species introduced into Minnesota are identified as such.

The Atlas itself occupies over 200 pages. After an outline map showing the location of the 87 Minnesota counties, the 1,881 species maps begin, nine on each page. The 8 1/2 x 11″ format of the book allows each map to be 2 1/4 x 2 3/4″, clearly showing the distributional data. Rather than including a single dot per county, the authors have chosen "for accuracy" to plot exact collection localities; one dot represents multiple collections only when they were made within a radius of three miles!

While this book is a significant volume that should be immensely useful, just as with most any book in the hands of a reviewer, a few "nits" can be picked. Not all of the species in the Checklist (2,010) appear in the Atlas (1,881). The authors admit this in the Introduction, noting that all native species and "introduced species that have become naturalized" are included. Unfortunately, it is not always clear from the Checklist which species are not mapped since map numbers are listed only for the genera. As an

example, 35 of the 45 species of Caryophyllaceae listed in the Checklist are mapped. When one looks up *Gypsophila* in the Checklist, three species are listed, each as "Introduced," but only a single map is given. Which species is mapped? Flipping to the atlas is the only solution.

The treatment of infraspecific taxa is also uneven. Some species with several listed varieties appear as single maps (e.g., *Lactuca canadensis* L., *Stellaria longifolia* Muhlenb. ex Willd.) while in other cases each variety is mapped (e.g., *Panicum lanuginosum* Elliott, *Ranunculus hispidus* Michaux). Again, the reader is left with an incomplete picture.

My work on the Caryophyllaceae has made me very aware of the treatment that introduced species often receive in floristic manuals. Although the authors have clearly noted each introduced species in the checklist and mapped many, one very useful element could have been added—*when* the introduced species were collected. Are all specimens collected before 1920? After 1980? Such information, either breifly stated in text (as in Voss) or by using different map symbols (as in the *Preliminary Atlas of New York State Plants*), is useful in illustrating which plants are likely to be members of the contemporary flora.

These issues aside, *Vascular Plants of Minnesota: A Checklist and Atlas* provides a great deal of information about the flora of the largest state in the Great Lakes Region. Botanists of the region should not be without a copy.

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MINNESOTA'S ENDANGERED FLORA AND FAUNA. By Barbara Coffin & Lee Pfannmuller, editors. University of Minnesota Press, 2037 University Avenue SE, Minneapolis, Minnesota 55414. 1988. xv + 473 pp. $49.50 (cloth); $16.95 (paper); postpaid with check, MC, or V.

By some estimates, our species takes 40% of the earth's primary productivity for itself. That leaves only 60% for the ten or so million other creatures with whom we share the biosphere. What share of the habitats we take is probably even greater than 40%; hence, the present volume.

Books like this need to be written; this one is a model of how it ought to be done. The coverage is exhaustive: separate sections on vascular plants, nonvascular plants (mosses), nonvascular plants (lichens), and all the major groups of vertebrate and invertebrate animals. The contributors are the best botanists and zoologists in the state. Within each major group of plants, the sequence is alphabetical by genus; for the animals, the sequence is alphabetical by common name. Given the differing roles of common names in the two, the arrangement is eminently sensible and convenient for the reader. A comprehensive index to both Latin and common names at the end of the volume makes access simple.

For each endangered or threatened species, there are distribution maps for Minnesota occurrence and for general occurrence, followed by (1) basis for status, (2) preferred habitat, (3) aid to identification, and (4) selected references. For species of special concern, the treatment is shortened, with two distribution maps and briefer statements about occurrence and habitat.

Vascular plant species in the first category are accompanied by superb illustrations from the hand of Vera Ming Wong. No less skillful are the drawings of the nonvascular plants and the animals; the artists include Miss Wong, plus Nan Kane, Don Luce, James Tidwell, Jan Janssens, and Kris Kohn. They deserve to be named—the illustrations alone are worth the price of the book.

The aids to identification are very useful. The paragraph on how to distinguish *Poa paludigena* (page 129) from some similar species will drive me to take out herbarium specimens and recheck the identifications.

The vascular plant nomenclature is apparently up-to-date, and brief citations of synonymy are helpful; nonetheless, I got lost on *Sedum integrifolium* (page 146), partly because the authority for the binomial, (Raf.) Hultén, was omitted. The species is treated so variously in current American floras that the addition of more synonymy would have been useful.

The book is superb. One regrets only its necessity: "Man is the only animal who blushes—or needs to." The work deserves a place on the shelves and in the hands of everyone who cares about the biosphere.

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CONTEMPORARY PLANT SYSTEMATICS. By Dennis W. Woodland. Prentice-Hall Publishing, 200 Old Tappan Road, Old Tappan, New Jersey 07675. 1991. x + 582 pp. $53.00 (cloth).

There are numerous introductory textbooks in [vascular] plant taxonomy. However, this one is different, because it is aimed both at the college undergraduate and at the serious amateur.

The introductory chapters are especially well done: "The Significance of Systematics," "How Plants Get Their Names," "The Literature of Systematics," "How Plants Are Identified," "Collecting, Handling, and Preserving Specimens." There are numerous helpful hints together with careful instructions, and comments on ethics of collecting and handling specimens.

Then the author gets technical, but with a difference: he takes up the families of ferns and their allies, for example, but with explanations and generally excellent diagrams of their life cycles—this last a feature rarely seen in textbooks of vascular plant taxonomy. The families of gymnosperms (Pinophyta) are treated similarly.

Only at Chapter 8 does the book treat the terminology of flowering

plants, again with a life cycle given. Here the author had to exercise the most judgment in what to include, what to exclude; all in all, I think he has made wise choices, with enough detail to get the student familiar with the most commonly encountered terms. In the diagram of leaves on page 118, I could wish that leaves with three leaflets were called "trifoliolate," instead of "trifoliate," which properly means having three leaves, as in *Trillium*.

Chapters 9 and 10 treat the dicots (Magnoliopsida) and monocots (Liliopsida) in Cronquistian sequence. Unfortunately, there are no arguments preceding these chapters that would function to explain how Cronquist arrived at his system. There needs to be at least a "key" to facilitate one's understanding of the scheme. In fairness, it should be pointed out that if all the arguments were given, the book might well have ended up being half again as big as it is.

The families (almost all get one page each) are grouped into orders, but the ordinal name is only given before the first family of the order, so it gets tricky to determine what order a family is assigned to—you have to do a lot of page-turning. Because the characters of the orders are not given, it must be taken on faith that, for example, the Onagraceae and Lythraceae belong in the Myrtales. The illustrations seem competently done and are generally helpful. Sometimes, terms creep in that are not defined elsewhere; one is told that members of the Caryophyllales of subclass Caryophyllidae have seeds with perisperm in place of endosperm, but "perisperm" is nowhere defined, though "endosperm" is.

Chapters 12 through 15 discuss origins of vascular plants (generally done in greater depth in introductory botany textbooks), contemporary methods in plant systematics (with an inevitable and totally obscure diagram of chloroplast DNA), endangered and threatened species, and lastly "The Role of Botanical Gardens in Society," with photographs and discussions (especially history) of some of the world's great institutions—an altogether excellent innovation in books of this sort.

There are two appendices; the first, "Floras of the World," is an abbreviated but nonetheless useful compendium; there is no cutoff date given, but it appears to be about 1988. The second, "Classification of the Division Magnoliophyta," gives a complete rundown of the Cronquistian system; it tells *where* every family falls, but again it does not even hint at *why*.

There are curious little slips here and there in the book: the abbreviation for *id est* is often used when the abbreviation for *exempli gratia* was intended; "stamens alternate *with* the petals" is idiomatic, "stamens alternate the petals" is not; names of families, orders, subclasses, and classes, plurals all, are sometimes treated as grammatically singular, sometimes as grammatically plural; corolla is given as plural of petal, when of course it's a collective term, not a plural (the linguistic relationship between calyx and sepal is given correctly).

I think the book will serve well its intended function. With ample illustrations and written in a friendly, direct style, it will not overwhelm either the

beginning undergraduate or the serious amateur. At a little under ten cents per page, the price is fair.

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LIVERWORTS AND HORNWORTS OF SOUTHERN MICHIGAN. By Howard Crum. University of Michigan Herbarium, Ann Arbor, MI 48109-1057. 1991. 233 pp. $18.00 U.S.; $20.00 Non-U.S. orders, (hardcover).

Michigan and Minnesota are arguably the best known states bryologically. Our knowledge of Minnesota is largely due to the works of Rudolf Schuster, while that of Michigan is due to the long lineage of bryologists associated with that state. The University of Michigan Biological Station in Cheboygan County, one of the northernmost counties in the lower peninsula, for many years has held a bryophyte course taught by a notable bryologist, i.e., George Nichols, William C. Steere, Margaret Fulford, Paul Patterson, A. J. Sharp, and Howard Crum. The University of Michigan, Ann Arbor campus, has had a long-standing bryology program under the guidance of William Campbell Steere and later Howard Crum, a student of Steere. Crum is a noted authority of mosses and author of "Mosses of the Great Lakes Forest" (now in the third edition) and "Mosses of Eastern North America" (with Lewis Anderson). William Steere authored *Liverworts of Southern Michigan,* a guide that for many years served as a useful, nontechnical resource for a broad audience. Howard Crum's book is intended to replace the now dated treatment of Steere.

The treatment covers 42 counties south of the "Tension Zone", a band roughly 1–2 counties broad lying in the approximate middle of Lower Michigan and extending across the state from Saginaw Bay westward. The area below the tension zone is a naturally defined area, and has been referred to in the literature as "Southern Lower Michigan." Growing conditions north and south of the tension zone are contrasted in the book, and the differences constitute the rationale for a separate treatment of the hepatic flora of southern Lower Michigan.

The book is nicely organized. A general discussion of the morphology and development of hepatics precedes a key to the liverwort orders that occur in Michigan. Crum (p. 20) states "The text is not phylogenetic in organization. The simplest and most reduced liverworts are placed in the beginning even though their simplicity speaks of a derived rather than a primitive stage of development". Thus Marchantiales is treated first, fol-

lowed by Metzgeriales, Jungermanniales, and lastly the class Anthocerotophyta. Treatment of each order begins with a useful general discussion of morphology and development of the group together with comments on some of the genera where appropriate. In each case a key to the genera of the order follows the discussion. Families are used only as a matter of convenience for grouping the genera, and are intentionally not accompanied by a description or discussion. Rather, a family name is followed by a citation and a proselike description of the genus, interesting comments on the derivation of the generic name, comments where appropriate on the morphology and development of the genus, reference to occurrence of the genus in Michigan, and a key to the included species. This information is for the most part nontechnical, which increases the breadth of the audience.

Each of the 76 species known for the area is accompanied by a proselike description, comments on derivation of the name and discussion of the occurrence and ecology of the species in Lower Michigan as well as of the biology of the species. Species discussions are often accompanied by interesting comments on the odor, taste, and texture of the plants.

A useful glossary, bibliography, section of 104 figures, and two indices (subject and taxonomic) comprise the latter sections of the book. Figures are of several different types. Some are photomicrographs, such as capsule sections (*Conocephalum conicum,* p. 147), while others are photographs (a number of them rarely published) such as sporophyte-bearing female receptacles of *Conocephalum* and the female receptacle of *Reboulia hemisphaerica.* Still others are *in situ* photographs, such as of *Fossombronia cristula* and of *Plagiochila porelloides.* Most figures, however, are useful line drawings showing habit and morphological detail.

The book is sprinkled with entertaining quotes from a wide variety of sources. Ezekial is quoted at the end of the text, "An end is come, the end is come; it watcheth for thee; behold it is come." Among several others is my favorite; Crum refers to his long association with his wife Irene and comments the "she sees the sense of Robert Frost's doggerel:

It takes all sorts of in and outdoor schooling
To get adapted to my kind of fooling."

The book has a niche—it is written for a broad audience and therefore should have broad utility. It should be of interest to amateurs as well as students and professionals in Botany and allied fields. Some may find it advantageous to use the book as a starter, prior to consultation with more technical works. I recommend it for both students and professionals.

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THE MICHIGAN BOTANIST

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Flora of Sleeping Bear

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Membership in the Michigan Botanical Club is open to anyone interested in its aims: conservation of all native plants; education of the public to appreciate and preserve plant life; sponsorship of research and publication on the plant life of the State; sponsorship of legislation to promote the preservation of Michigan native flora; establishment suitable sanctuaries and natural areas; and cooperation in programs concerned with the wise use and conservation of all natural resources and scenic features.

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THE FLORA OF SLEEPING BEAR DUNES NATIONAL LAKESHORE, BENZIE AND LEELANAU COUNTIES, MICHIGAN

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INTRODUCTION

The scenic vistas, prominent headlands, and long, open shorelines of Sleeping Bear Dunes National Lakeshore are outstanding natural features. The richness of the Lakeshore's physiography can be attributed to its legacy of moraines and outwash plains, and to the postglacial effects of water and

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wind which formed relict beach ridges, bluffs, and dunes. Streams, lakes, and wetlands contribute to the diversity of the landscape. No less important are the various natural plant communities which have developed on, and in association with, these landforms, making the Sleeping Bear region a prime area for botanical investigations.

This paper has two sections. The first includes a description of the National Lakeshore's vegetation and emphasizes botanically interesting areas, most of which are easily accessible by trail. Common names are used whenever possible throughout this section. The second section is a catalog of vascular plants which notes habitats and species abundance.

The National Lakeshore (Fig. 1), created by Congress in 1970, covers over 58,000 acres (23,490 ha) in Benzie and Leelanau Counties from its southernmost boundary near Round Lake north to the Manitou Islands. (A descriptive brochure with a more detailed map of the National Lakeshore can be obtained through the Visitor Center, Sleeping Bear Dunes National Lakeshore, Empire, MI 49630.) Its mainland portion is composed of three major sections: the Platte River unit, largely in Benzie Co., covering 14,299 acres with 11 miles of Lake Michigan shoreline; the Sleeping Bear Dune unit, covering 11,786 acres with 7.5 miles of Lake Michigan shoreline; and the Good Harbor Bay unit covering 11,394 acres with 11 miles of Lake Michigan shoreline. The National Lakeshore also includes the Bow Lakes unit, 975 acres southeast of Glen Lake. South Manitou, lying about 7 miles from Sleeping Bear Point, the nearest mainland, covers 5,260 acres. North Manitou, situated about 7 miles from the nearest mainland at Pyramid Point, lies about 3.5 miles northeast of South Manitou and covers 14,753 acres.

The Manitou Islands were the first areas to be explored and settled in the region now encompassed by Sleeping Bear Dunes National Lakeshore. Opportunistic botanists, such as George Engelmann during a trip in 1840, made collections, perhaps while their ships took on cordwood fuel. In August 1866, O. B. Wheeler, assistant engineer for the U. S. Lake Survey, picked up red anemone (*Anemone multifida*) on North Manitou. Twenty years later, Frederick Wislizenus, son of the noted St. Louis doctor and botanist, Friedrich Adolph Wislizenus, spent just over a week (July 25-Aug. 3) on North Manitou. Grass-pink (*Calopogon tuberosus*), pitcher-plant (*Sarracenia purpurea*), and flat-leaved bladderwort (*Utricularia intermedia*) specimens suggest that Wislizenus made some collections at Tamarack Lake, an easy trip from Aylesworth (later known as Crescent) on the island's west side.

E. J. Hill, an Indiana botanist, collected a few common shoreline plants on the Manitous in 1873 and even published a few of his observations (1900). Brief descriptions of North Manitou's dunes (Cowles 1899), forests (Whitford 1901), and wetlands (Coulter 1904) also appear in papers from this time period. Regularly scheduled stops on North Manitou by passenger boats from Chicago probably allowed Cowles to bring 12 students to the island in 1898 (Rodgers 1944). Some of Cowles's plant collections date from 1906 in addition to 1898, suggesting at least two trips to the island. E. N.

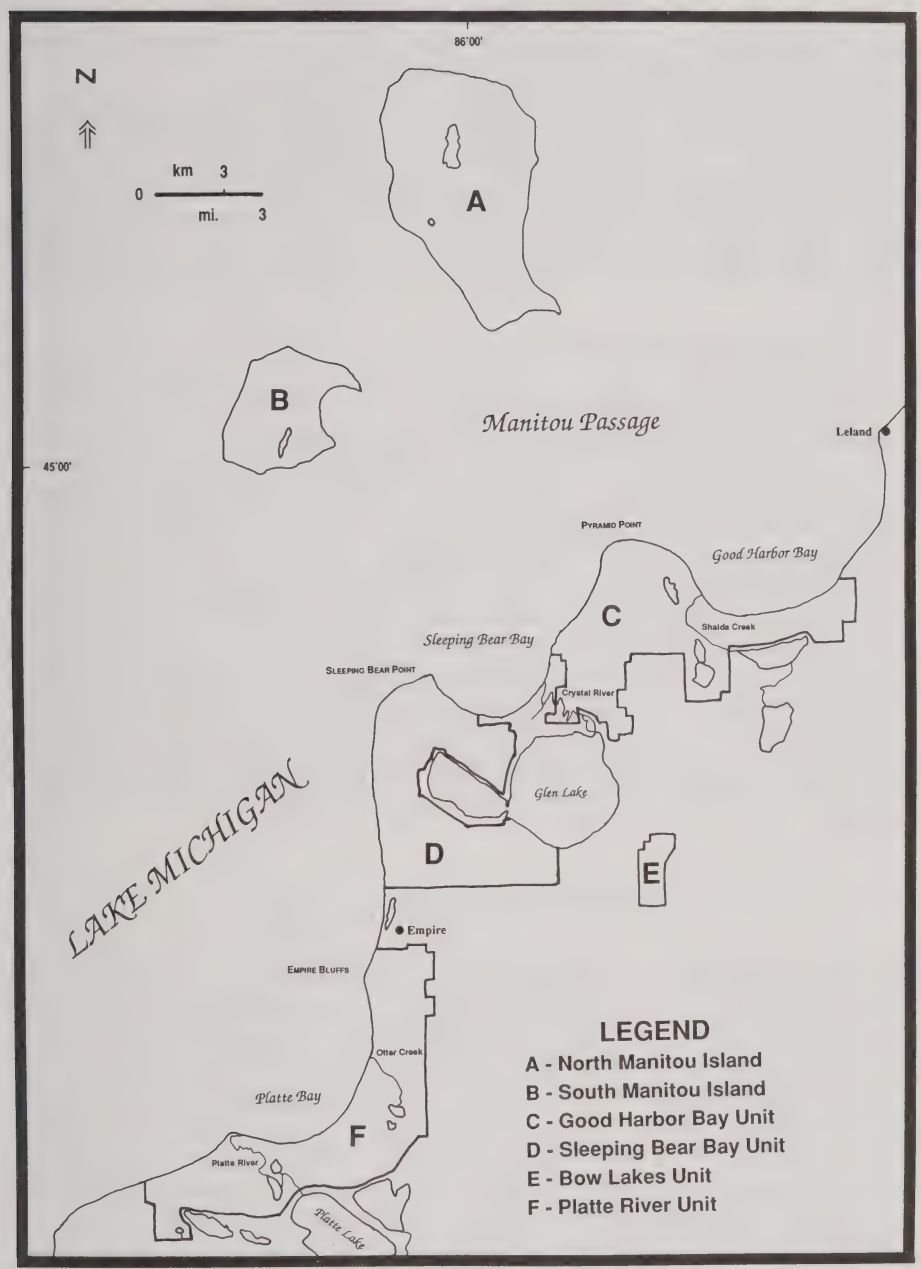

FIGURE 1. Sleeping Bear Dunes National Lakeshore.

Transeau also visited the island about this time. His collection labels indicate he was on North Manitou in August 1900 and a photograph from North Manitou is credited to him by Whitford (1901).

The mainland dunes of Sleeping Bear Point and the Sleeping Bear Plateau were also briefly described by Cowles (1899). Later Waterman (1922, 1926) provided more detailed vegetation descriptions of the regions near Sleeping Bear Point and near the Platte River. The vegetation and changing appearance of the Sleeping Bear Dune have been documented by Gates (1950) and Gillis and Bakeman (1963). A general description of the vegetation of the entire Sleeping Bear region has been written by Thompson (1967).

The natural vegetation of the National Lakeshore has been influenced by human activity since the mid-1800s. The islands especially proved to be convenient refueling stations for steamers before similar activity on the mainland. Agriculture usually succeeded the initial cordwood and timber production. Later the region became a popular recreation area for summer residents and tourists. Both agriculture and recreation, however, have been more intense on the mainland portion of the National Lakeshore than on the Manitous due to greater accessibility during the last century.

The main centers of agriculture in the National Lakeshore are presently near the north end of the Platte River unit, near Pyramid Point, and along M-22 at the east end of the Good Harbor Bay unit. Haying is the principal activity near Pyramid Point, and orchards are found at the east end of the Good Harbor Bay unit. Orchards are also a part of the agricultural activity at the north end of the Platte River unit in addition to alfalfa and corn production. Throughout the National Lakeshore are old fields, at various stages of secondary succession, showing agriculture was once more widespread.

GLACIAL AND POSTGLACIAL GEOLOGY

The recent geologic history of the Sleeping Bear Dunes region is detailed elsewhere (Calver 1946; Drexler 1975; Rogers 1966; Upchurch 1973). Initially the region was covered by glacial ice. These moving ice sheets deposited formations known as moraines, which today compose the majority of the hills and bluffs within the National Lakeshore. In places the moraines were re-shaped when glacial melt-water formed outwash channels. Moraines adjacent to Lake Michigan and its predecessors were eroded to form bluffs, and some of this eroded material was redeposited, rounding out the shorelines. Parts of the National Lakeshore were inundated when the water level in the Lake Michigan basin was at least 25 feet higher than at present. As these levels receded to the present level, areas of lake plain were exposed. Often beach ridges and dunes mark this drop in lake level. Other dunes formed atop moraines from sand blown directly from the exposed morainal bluffs. These are perched dunes in contrast to coastal dunes formed at lake level.

PLATTE RIVER UNIT

Physiographically, the Platte River unit is largely a collection of irregular dunes which have formed on lake plain. Morainal deposits occur at the south end of the unit, but the most prominent morainal area is the Empire Bluffs region at the north end of the unit. Also passing through the north end is a large sinuous outwash channel now largely occupied by fields. The Platte River unit includes several lakes (Round Lake, Loon Lake, Mud Lake, Deer Lake, Bass Lake, and Otter Lake) and two major streams (Otter Creek and the Platte River).

Round Lake Area

Park visitors usually catch a glimpse of Round Lake east of M-22 immediately after entering Sleeping Bear National Lakeshore from the south. The lake occupies about 16 acres and has a marly bottom. Floating and submerged aquatics include water-milfoil (*Myriophyllum* sp.), naiad (*Najas flexilis*), pond-lily (*Nuphar variegata*), water-lily (*Nymphaea odorata*), pond-weeds (*Potamogeton* spp.) and bladderworts (*Utricularia* spp.). A floating sedge (*Carex* spp.) mat occupies the rest of the lake basin on the south side and an outlet flows south through the mat to Crystal Lake. Other herbaceous species found on the mat include swamp milkweed (*Asclepias incarnata*), *Calamagrostis inexpansa*, marsh bellflower (*Campanula aparinoides*), water-hemlock (*Cicuta bulbifera*), twig-rush (*Cladium mariscoides*), sundew (*Drosera rotundifolia*), spike-rush (*Eleocharis* sp), cotton-grass (*Eriophorum* spp.), joe-pye-weed (*Eupatorium maculatum*), bone-set (*Eupatorium perfoliatum*), rushes (*Juncus* spp.), Kalm's lobelia (*Lobelia kalmii*), bugle-weed (*Lycopus uniflorus*), buckbean (*Menyanthes trifoliata*), royal fern (*Osmunda regalis*), reed (*Phragmites australis*), marsh cinquefoil (*Potentilla palustris*), hardstem bulrush (*Scirpus acutus*), hooded ladies'-tresses (*Spiranthes romanzoffiana*), marsh fern (*Thelypteris palustris*), marsh St. John's-wort (*Triadenum fraseri*), common cat-tail (*Typha latifolia*), and bladderworts. Woody species scattered across the sedge mat and around its outer edges include white birch (*Betula papyrifera*), bog birch (*B. pumila*), silky dogwood (*Cornus amomum*), red-osier (*C. stolonifera*), swamp loosestrife (*Decodon verticillatus*), sweet gale (*Myrica gale*), swamp rose (*Rosa palustris*), willows (*Salix* spp.), and white cedar (*Thuja occidentalis*).

To the east of Round Lake and to the west on the opposite side of M-22 is moraine which is largely covered with northern hardwoods consisting of beech (*Fagus grandifolia*), sugar maple (*Acer saccharum*), white birch, black cherry (*Prunus serotina*), and white ash (*Fraxinus americana*). Other trees include hemlock (*Tsuga canadensis*), yellow birch (*Betula alleghaniensis*), and basswood (*Tilia americana*). The only known location within the National Lakeshore for broad beech-fern (*Thelypteris hexagonopteris*) is on this moraine.

Platte Bay Region

After passing Round Lake, M-22 turns eastward and continues along the boundary of the National Lakeshore to a bridge at the Platte River. The forested region between M-22 and the coastal dunes of Lake Michigan is a diverse assortment of vegetated dunes and dune ridges interspersed with swales and ponds. Access to this area south of the Platte River can be made via Old Indian trail or Cooper (Boekeloo) Road. The coastal forests along this part of Platte Bay are primarily composed of red maple (*Acer rubrum*), white pine (*Pinus strobus*), white birch, red pine (*Pinus resinosa*), big-tooth aspen (*Populus grandidentata*), red oak (*Quercus rubra*) and white oak (*Q. alba*). Common understory species include choke cherry (*Prunus virginiana*), serviceberry (*Amelanchier* spp.), witch-hazel (*Hamamelis virginiana*), low sweet blueberry (*Vaccinium angustifolium*), and huckleberry (*Gaylussacia baccata*). Herbs most frequently encountered include wintergreen (*Gaultheria procumbens*), trailing arbutus (*Epigaea repens*), Canada mayflower (*Maianthemum canadense*), large-leaved aster (*Aster macrophyllus*), rice-grass (*Oryzopsis asperifolia*), cow-wheat (*Melampyrum lineare*), stemless lady-slipper (*Cypripedium acaule*), wood betony (*Pedicularis canadensis*), and fringed polygala (*Polygala paucifolia*).

Ponds and swales most commonly occur among the dunes covered by the coastal forests south of the Platte River. The woody vegetation of the swales is largely composed of alder (*Alnus rugosa*), dogwoods, and tamarack (*Larix laricina*). Other species include willows, Michigan holly (*Ilex verticillata*), swamp rose, nannyberry (*Viburnum lentago*), and chokeberry (*Aronia prunifolia*). White cedar becomes more common in swales farthest from Lake Michigan.

The coastal dunes south of the Platte River are among the least visited in the Park due to their limited accessibility. Woody species of the dunes include jack pine (*Pinus banksiana*), common juniper (*Juniperus communis*), and balsam poplar (*Populus balsamifera*). Dune grasses here include little bluestem (*Andropogon scoparius*), *Agropyron dasystachyum, Elymus canadensis,* June grass (*Koeleria macrantha*), *Calamovilfa longifolia*, and beach grass (*Ammophila breviligulata*). Other dune species include beach pea (*Lathyrus japonicus*), evening primrose (*Oenothera oakesiana*), beach heath (*Hudsonia tomentosa*), sand cherry (*Prunus pumila*), sand cress (*Arabis lyrata*), common milkweed (*Asclepias syriaca*), Pitcher's thistle (*Cirsium pitcheri*), puccoon (*Lithospermum caroliniense*), wormwood (*Artemisia caudata*), bearberry (*Arctostaphylos uva-ursi*), starry false Solomon's seal (*Smilacina stellata*), harebell (*Campanula rotundifolia*), Kalm's St. John's-wort (*Hypericum kalmianum*), scouring-rush (*Equisetum hyemale*), poison-ivy (*Toxicodendron radicans*), and grape (*Vitis riparia*). Pitcher's thistle (Fig. 2), readily found on all dunes of the National Lakeshore, is a federally listed threatened species as well as a Michigan threatened species (Michigan Department of Natural Resources (MDNR) 1989). This region also has a collection of dune pools characterized by spikerushes, rushes, sedges, willows, Kalm's lobelia, horned bladderwort

FIGURE 2. Pitcher's thistle (*Cirsium pitcheri*).

(*Utricularia cornuta*), balsam ragwort (*Senecio pauperculus*), and white camas (*Zigadenus glaucus*).

The coastal forests north of the Platte River tend to be drier than those south of the river. Typical overstory species include red oak, white oak, red pine, jack pine, and white pine. A large area of open, relictual dune ridges occurs near Lake Michigan along Peterson Road. This area has a collection of dune species, old field species, and species of the surrounding coastal oak-pine forest. Of particular note are butterfly weed (*Asclepias tuberosa*), bastard toadflax (*Comandra umbellata*), frostweed (*Helianthemum canadense*), bluets (*Houstonia longifolia*), dwarf dandelion (*Krigia virginica*), blue toadflax (*Linaria canadensis*), rock spikemoss (*Selaginella rupestris*), and sleepy catchfly (*Silene antirrhina*). For hikers, the Platte Plains trail system with trailheads at the Platte River Campground and at the ends of both Esch and Trail's End roads provides convenient access to this coastal forest area.

The vegetation of coastal dunes north of the Platte River is very similar to those dunes south of the river although red osier and creeping juniper (*Juniperus horizontalis*) appear to be more common. Broom-rape (*Orobanche fasciculata;* Fig. 3), a species parasitic on wormwood and listed as threatened in Michigan (MDNR 1989), seems to be more common on the dunes from here northward.

Platte River Area

Canoe liveries, campgrounds, a picnic area, and a District Ranger Station are clustered around the M-22 bridge at the Platte River. From here Lake Michigan Road proceeds west to Platte Point. The river is perhaps the easiest place to become familiar with Lakeshore aquatics due to the availability of rental canoes. The river enters the National Lakeshore about 1/8 mile upstream from the bridge and then proceeds about one mile to Loon Lake. Enroute to Loon Lake, the river bends near the outlet of Mud Lake. This lake (59 acres) is most easily observed from Lake Michigan Road (about 3/4 miles west of M-22). The water is very shallow, perhaps no more than a foot deep over a sandy bottom, and is characterized by a suspension of black organic matter which probably contributed to the lake's local name. Submerged and floating aquatics are quite rare with pond-lily and water-lily the most common.

The Platte River enters the east side of Loon Lake (95 acres) and exits on the north. The floating and submerged aquatics, most common at the lake's south end, include coon-tail (*Ceratophyllum demersum*), water-milfoil, pond-lily, and pond-weeds. Shoreline and emergent herbs include joe-pye-weed, bone-set, cardinal flower (*Lobelia cardinalis*), royal fern, marsh fern, and sedges. A dense shrub zone bordering the lake on the west and north sides is mainly composed of alder, chokeberry, bog birch, sweet gale, swamp rose, and nannyberry.

After exiting the lake, the Platte flows about 2.5 miles to the river mouth near the end of Lake Michigan Road. The river begins to meander in large loops just over a mile upstream from Lake Michigan. Swales, similar to

FIGURE 3. Broom-rape (*Orobanche fasciculata*).

those in the coastal forests to the south, run perpendicular to the river here. A few submerged aquatics occur along the stretch before Loon Lake, but they are most abundant between Loon Lake and Lake Michigan.

Floating and submerged aquatics found in the river include coon-tail, elodea (*Elodea canadensis*), water star-grass (*Heteranthera dubia*), duckweed (*Lemna minor*), water-marigold (*Megalodonta beckii*), water-milfoils, naiad, pond-lily, water-lily, water smartweed (*Polygonum amphibium*), pond-weeds, bladderworts, and tape-grass (*Vallisneria americana*). Among the shoreline herbs are marsh-marigold (*Caltha palustris*), sedges, spike-rushes, southern blue flag (*Iris virginica*), tufted loosestrife (*Lysimachia thyrsiflora*), purple loosestrife (*Lythrum salicaria*), royal fern, reed, marsh cinquefoil, hardstem bulrush, nightshade (*Solanum dulcamara*), bur-reeds (*Sparganium* spp.), marsh fern, and common cat-tail. Typical shrubby species include alder, chokeberry, red-osier, swamp loosestrife, Michigan holly, sweet gale, swamp rose, willows, and grape. Water-marigold, turtle-head (*Chelone glabra*), and purple meadow-rue (*Thalictrum dasycarpum*) are species more common in or along the Platte River than anywhere else in the National Lakeshore.

The development of the vegetation along the edges of Platte River as it nears its mouth is not as extensive today as it was forty years ago. Waterman (1922, p. 28) included an oblique aerial photograph of the river looking eastward, upstream toward the present location of Lake Michigan Road. The open water is narrower in the photograph than it is today and is bordered by "grass meadows", densely developed mats of grasses and sedges. These grass meadows may be similar to vegetation now found south of Round Lake or upstream from the Otter Creek bridge near the Marl Springs. A later photograph of the same area (Calver, 1946, p. 56) shows the Platte River to be even narrower. These photographs show encroachment of the marginal vegetation on the center of the river. Vegetation differences between the two photographs might be attributed to differences in the time of year they were taken and the volume of water moving down the river in addition to the actual growth rate of the vegetation.

Today many of the areas appearing as grass meadows in these early photographs are flooded. The river channels shown in these photographs, however, are still visible, as they are now partially lined with swamp loosestrife. No doubt increased river traffic (e.g. canoes, motor boats) over the last 40 years has had some influence in preventing the development of grass meadows and other vegetation along the river, but the water level in the river may be a more important factor. Waterman (1922) suggested that the grass meadows along the Platte River formed rapidly and would grow as river level (dependent on Lake Michigan levels) dropped.

Aral Dunes/Otter Creek Area.

The Aral Dunes/Otter Creek area is among the most floristically diverse areas in the National Lakeshore. This area has a collection of open coastal dunes, jack pines, coastal oak-pine forests, northern hardwoods, and a

variety of wetlands associated with Otter Creek. Exploration of this area can begin from the site of Aral, a lumber town on the Lake Michigan shore at the end of Esch Road. The typical visitor comes here for the opportunities to enjoy the sandy beaches, but the town was established here because of the water power supplied by Otter Creek.

The jack pine stands, characterized by jack, red, and white pine are very well developed on the Aral Dunes (south of the end of Esch Road.). In moist dense stands, cedar occurs in the overstory and species such as bearberry, *Carex eburnea*, pipsissewa (*Chimaphila umbellata*), striped coralroot (*Corallorhiza striata*), stemless lady-slipper, rattlesnake-plantain (*Goodyera oblongifolia*), twinflower (*Linnaea borealis*), buffaloberry (*Shepherdia canadensis*), and one-sided pyrola (*Pyrola secunda*) are found. Ram's-head lady-slipper (*Cypripedium arietinum*), listed as of special concern in Michigan (MDNR 1989), is relatively abundant in some of these stands.

At the upper end of the Otter Creek drainage basin are three lakes. Deer Lake, the smallest (6 acres), is characterized by large floating mats of *Chara*, an alga common in calcareous waters. The lake is fed by springs and an intermittent stream. A short outlet connects it to the south side of Bass Lake (29 acres), which in turn is emptied by an outlet on its north side which flows to Otter Lake, the largest of the three (64 acres). Otter Creek leaves the lake on its north side.

Otter Creek begins its 1.5 mile course to Lake Michigan from Otter Lake by flowing north through a cedar swamp before encountering an open marsh. Along this route the creek is joined by smaller spring-fed tributaries. The largest group of these, the Marl Springs, occurs just east of the marsh (Fig. 4). The creek narrows after passing the marsh, flows under the two-track near Aral, and then empties into Lake Michigan.

Chara carpets much of the stream north of the marsh. Submerged and floating aquatic vascular plants are most common from the upper end of the marsh to the bridge. Otter Creek is the only place where mare's-tail (*Hippuris vulgaris*) has been found in the National Lakeshore, and the only locality for white water crowfoot (*Ranunculus longirostris*) on the mainland portion of the National Lakeshore.

Calver (1946) considered the basin now occupied by the marsh to be the remains of an extinct lake, perhaps from a higher level in Lake Michigan. Around 1900, it was flooded by the reservoir of a lumber mill dam built where the creek narrows. Today some of this area is covered by a sedge mat which has developed over a marly substrate. Herbaceous species include marsh cinquefoil, hardstem bulrush, and common cattail. Some bladderwort species even occur in wet areas of the mat. Scattered shrubs around the edge of the mat include alder, sweet gale, swamp rose, and some willow species. Just upstream from the marsh, bog species such as tamarack, pitcher-plant, and sundew are found along the creek's edge.

Cedar swamps border the creek for much of its journey. An area best representing this vegetation association is found on the west side of Otter Creek near the two-track bordering the oak-pine forested dunes. Here the

FIGURE 4. Oblique aerial view from the west of marsh along Otter Creek.

dominant tree is white cedar, but balsam fir (*Abies balsamea*), white pine, and tamarack are easily found. Understory species are predominantly balsam fir and white cedar. Among the herbs are jack-in-the-pulpit (*Arisaema triphyllum*), lady fern (*Athyrium filix-femina*), rattlesnake fern (*Botrychium virginianum*), sedges, dwarf enchanter's-nightshade (*Circaea alpina*), corn-lily (*Clintonia borealis*), goldthread (*Coptis trifolia*), striped coralroot, early coralroot (*Corallorhiza trifida*), bunchberry (*Cornus canadensis*), bulblet fern (*Cystopteris bulbifera*), crested shield fern (*Dryopteris cristata*), wild strawberry (*Fragaria virginiana*), creeping snowberry (*Gaultheria hispidula*), water avens (*Geum rivale*), oak fern (*Gymnocarpium dryopteris*), blunt-leaf orchid (*Habenaria obtusata*), twinflower, Canada mayflower, partridgeberry (*Mitchella repens*), naked miterwort (*Mitella nuda*), cinnamon fern (*Osmunda cinnamomea*), royal fern, fringed polygala, marsh fern, star-flower (*Trientalis borealis*), velvet-leaf blueberry (*Vaccinium myrtilloides*), and *Viola blanda*. An open, marly site within this cedar

swamp provides habitat for bog-rosemary (*Andromeda glaucophylla*), leatherleaf (*Chamaedaphne calyculata*), spike-rushes, bog-candle (*Habenaria dilatata*), buckbean, water-lily, shrubby cinquefoil (*Potentilla fruticosa*), pitcher-plant, three-leaved false Solomon's seal (*Smilacina trifolia*), and horned bladderwort.

The vegetation of the Marl Springs area on the east side of the creek is similar to this cedar swamp. Noteworthy species found in this area include golden saxifrage (*Chrysosplenium americanum*), yellow monkeyflower (*Mimulus glabratus var. fremontii*), and water-parsnip (*Berula erecta*). Water-parsnip, listed as threatened in Michigan (MDNR 1989), is most common in the National Lakeshore in the cold calcareous waters of the Marl Springs. The plants are most readily found as a basal rosette of slightly toothed, pinnately compound leaves. It has small white flowers on the rare occasions when its blooms.

Empire Bluffs

The northern hardwood forests of the Platte River unit can best be observed south of Empire along the Empire Bluffs trail. This trail also includes a variety of other habitats including old fields and dunes. Species in the old field at the beginning of the trail include common milkweed, yellow rocket (*Barbarea vulgaris*), hoary alyssum (*Berteroa incana*), spotted knapweed (*Centaurea maculata*), ox-eye daisy (*Chrysanthemum leucanthemum*), wild carrot (*Daucus carota*), orange hawkweed (*Hieracium aurantiacum*), king devil (*H. piloseloides*), common St. John's-wort (*Hypericum perforatum*), black medic (*Medicago lupulina*), sulfur cinquefoil (*Potentilla recta*), sheep sorrel (*Rumex acetosella*), bladder campion (*Silene vulgaris*), goldenrod (*Solidago* spp.), goats-beard (*Tragopogon dubius*), red clover (*Trifolium pratense*), white clover (*T. repens*), and hairy vetch (*Vicia villosa*).

The trail quickly moves into a forest characterized by beech, sugar maple, white ash, and ironwood (*Ostrya virginiana*). Herbs here are quite diverse including wild leeks (*Allium tricoccum*), jack-in-the-pulpit, blue cohosh (*Caulophyllum thalictroides*), spring beauty (*Claytonia caroliniana*), two-leaved toothwort (*Dentaria diphylla*), squirrel-corn (*Dicentra canadensis*), Dutchman's breeches (*D. cucullaria*), evergreen wood fern (*Dryopteris intermedia*), marginal wood fern (*D. marginalis*), adder's-tongue (*Erythronium americanum*), herb robert (*Geranium robertianum*), waterleaf (*Hydrophyllum appendiculatum*), bishop's cap (*Mitella diphylla*), sweet cicely (*Osmorhiza claytonii*), hairy Solomon's seal (*Polygonatum pubescens*), zig-zag goldenrod (*Solidago flexicaulis*), common trillium (*Trillium grandiflorum*), bellwort (*Uvularia grandiflora*), Canada violet (*Viola canadensis*), and yellow violet (*V. pubescens*). In some places wood nettle (*Laportea canadensis*) is very profuse. Glade fern (*Athyrium pycnocarpon*) occurs in a ravine off this trail.

About midway to the bluffs, the trail passes through another old field. The prime botanical interest here is the presence of moonwort (*Botrychium*

lunaria), mingan moonwort (*B. minganense*), and ebony spleenwort (*Asplenium platyneuron*) under the white ashes which have invaded the field.

The trail re-enters the northern hardwoods and crosses large forested dunes before reaching the open dunes on the Empire Bluffs. Basswood is more common in the overstory here than in the woods at the beginning of the trail. Of special note is the profuse growth of yew (*Taxus canadensis*) in the forest close to the end of the trail. In most other northern hardwoods on the mainland, yew, a favorite deer food, has been severely browsed. Perhaps this population is protected by heavy snow cover in the winter. The flora of the dunes at the Empire Bluffs is similar to other dunes in the National Lakeshore. Steep slopes impede the exploration of this region, and those desiring to spend time on dunes should find more accessible areas.

SLEEPING BEAR DUNE UNIT

A dominant landform in the Sleeping Bear Dune unit is the perched dune complex of the Sleeping Bear Plateau, west of Little Glen Lake. A landmark since presettlement times, the Sleeping Bear rests about 400 ft. above Lake Michigan near the bluff edge. Gates (1950) began the documentation of the slow disappearance of this dune, which he believed was initiated by tree cutting by surveyors. This cutting exposed open sand to the wind which accelerated erosion. In 1935 Gates measured the dune's height to be 159 ft. above the plateau. By 1961 the dune had shrunk to a height of 132 ft. above the plateau, a drop of 102 ft. from the 1906 Army Corps of Engineers measurement of 234 ft. (Gillis & Bakeman 1963). Although no measurements have been published since 1961, it is likely that the erosion of this dune has continued.

The moraines of the Sleeping Bear Dune unit flank the south, west, and north shores of Little Glen Lake and part of the south shore of Big Glen Lake. Wooded bluffs, the products of erosion by higher lake levels, face north near Glen Haven, and westward south of the Sleeping Bear Bluffs. Some small areas of lake plain occur between these bluffs and Lake Michigan. North of Empire, M-22 follows an outwash channel to Glen Lake. North Bar Lake, two miles north of Empire, is the only lake entirely within the Sleeping Bear Dune unit.

The woods on the moraines south of Glen Lake are largely composed of sugar maple, beech, and white ash. Other common canopy species include basswood, hemlock, and ironwood. Ironwood and hemlock are most common as sub-canopy species. The understory is mainly composed of sugar maple and beech. Herbaceous vegetation appears to be more luxuriant with increasing elevation. The richest assemblages of herbs occur at the tops of the highest moraines and in the forests nearest Lake Michigan such as those near the Scenic Drive.

Sleeping Bear Plateau Area

The broad expanse of the perched dunes of the Sleeping Bear Plateau is a complex mosaic of sand and vegetation. Visitor access to the perched dunes of the Sleeping Bear Plateau can be made via the Pierce Stocking Scenic Drive, off M-109, or by trail from the parking lot at Sleeping Bear Point west of Glen Haven. The vegetation of the perched dunes here is very similar to that of the coastal dunes except the zonation of species from the open beach to forest is missing.

In many places the vegetation cannot keep pace with the movement of the sand. In such areas, dunes on the eastern edge of this area spill into adjacent northern hardwoods, or to the delight of many, in an area known as the Dune Climb, into an old field near Glen Lake. The movement of dunes closer to Sleeping Bear Point forced the relocation of the Sleeping Bear Point Coast Guard Station one mile east to its present location.

Low protected pockets on the perched dunes are often areas where woody species such as cottonwood (*Populus deltoides*), buffaloberry, red osier, bearberry, sand cherry, common juniper, and grape have become established. Dune grasses such as *Agropyron dasystachyum*, beach grass, little bluestem, *Calamovilfa longifolia, Elymus canadensis*, and June grass are among the first to colonize the open sand. Other dune species include horsemint (*Monarda punctata*), beach pea, broom-rape, bugseed (*Corispermum hyssopifolium*), white camas, evening primrose, false heather, common milkweed, green milkweed (*Asclepias viridifolia*), scouring-rush, Pitcher's thistle, puccoon, red anemone, sea rocket, sand cress, rock sandwort (*Arenaria stricta*), smooth aster (*Aster laevis*), balsam ragwort, gray goldenrod (*Solidago nemoralis*), and wormwood.

Some alien species such as white sweet clover and bladder campion have become common on these dunes. One species which has yet to become widespread here is baby's-breath (*Gypsophila paniculata*). Within the National Lakeshore it is most common on the dunes near a group of houses built on the open dunes north of the Platte River. Individuals of this species have been found at Empire Bluffs and the Sleeping Bear Plateau. It now covers the dunes at Point Betsie (south of the Lakeshore), so it may only be a matter of time before the National Lakeshore's dunes meet a similar fate.

Among the most interesting species occurring on these dunes is the dunewort (Fig. 5), a local variety of the prairie moonwort, *Botrychium campestre*. In 1982 Joseph Beitel, a University of Michigan Botany graduate student, found this fern on the dunes at Pyramid Point. Specimens were taken back to U-M for examination by Drs. Warren H. and Florence S. Wagner, experts in this group. In 1984 a larger population was found by Dr. Tony Reznicek, also of the University of Michigan, on protected dunes near Sleeping Bear Point. Additional populations were found a year later on the Sleeping Bear Plateau, Empire Bluffs, and South Manitou Island. These populations were typically found on, or in sands originating from, perched dunes. It has yet to be found on the perched dunes of North Manitou, but the small amount of this habitat on the island may be the limiting factor.

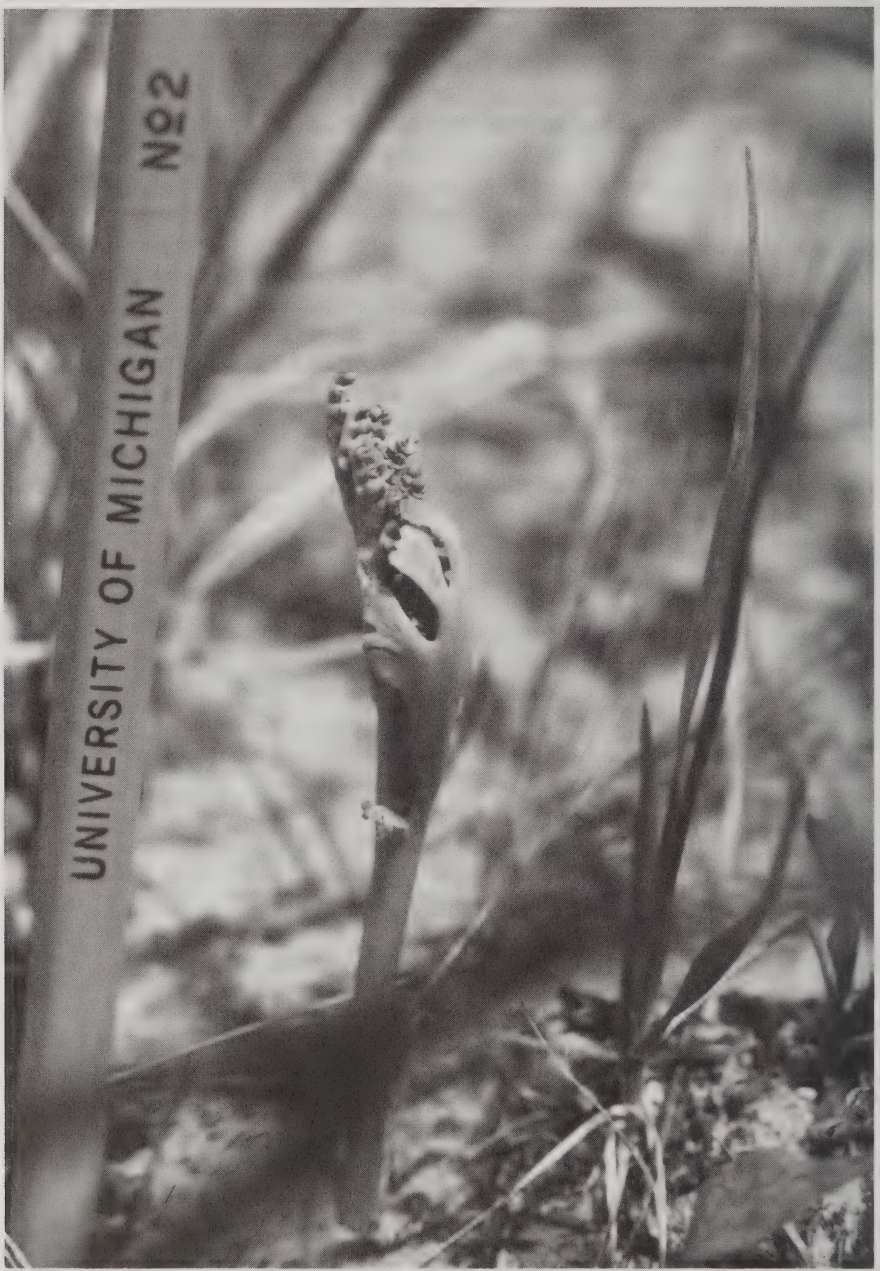

FIGURE 5. Dunewort (*Botrychium campestre*).

Outside the National Lakeshore, this fern has been found on perched dunes in Benzie County south of Frankfort, on South Fox Island, and on the Grand Sable Dunes of Pictured Rocks National Lakeshore. This species is listed as threatened in Michigan (MDNR 1989).

Those searching for this fern should seek moist, somewhat stable areas of perched dunes. For me, dandelions are good indicator plants. The best sites are low areas close to the underlying moraine. Occasionally these ferns will be found near junipers or in other shady areas. Usually several individuals are found in a given site. At maturity (mid June) these ferns are typically 1–2″ tall. By mid July, however, they have usually dispersed their spores and the aerial leaves have dried up.

An area near the Dune Climb which shows a profusion of aquatic species is the Day Mill Pond, a shallow six acre extension of Little Glen Lake. The Mill Pond, now ringed by common cattails, was once used in the operation of a lumber mill and is separated from the rest of Glen Lake by M-109. Species found here include bladderworts, coontail, duckweed, elodea, naiad, pond-lily, pondweeds, and water-milfoil. Of particular note here are the greater duckweed (*Spirodela polyrhiza*) and star duckweed (*Lemna trisulca*).

Alligator Hill Area

Alligator Hill lies north of Little Glen Lake. The trailhead for the Alligator Hill trail system is located on the west side of the hill near the corner of Day Forest and Stocking roads. The northern hardwoods of this area tend to be drier than those south of Glen Lake and on the outset appear to be less exciting botanically than other forests south and west of the lake. Among the noteworthy species found here, however, is the nodding pogonia or three-birds orchid (*Triphora trianthophora*), listed as threatened in Michigan (MDNR 1989). This orchid population, well north of its main southern range, was discovered in 1974 by John M. Van Arsdale, a science teacher in the Saginaw Valley school system. The population size has varied widely from year to year ranging from 7 to 200 (Van Arsdale 1982). Case (1987) noted that it is one of the rarer orchids of the Great Lakes region. Flowering in late August, often nearly all plants bloom at the same time with the flowers lasting only for a day.

GOOD HARBOR BAY UNIT

The Good Harbor Bay unit consists of some morainal hills in addition to dunes and coastal areas bordering Good Harbor Bay. The only perched dune area within the unit is at Pyramid Point. West of Glen Arbor, M-22 follows a glacial outwash channel. Aquatic habitats are mainly found in association with Tucker, Narada, Shell, School, and Bass Lakes, the Crystal River, and Shalda Creek.

The northern hardwoods on the moraines of this area tend to be slightly

drier and are largely composed of sugar maple, beech, white ash, and red oak. Associated species include hemlock, basswood, ironwood, and black cherry. Understory species are mainly beech, maple, ironwood, and some hemlock. Herbs are sparse.

On the south- and west-facing slopes of these moraines are sites characterized by bigtooth aspen and red oak with red maple, beech, and white pine as secondary associates. Understory species generally include sugar maple and beech saplings with some witch-hazel, striped maple (*Acer pensylvanicum*), and maple-leaved viburnum. These areas may eventually sustain northern hardwoods, but greater solar exposure on these slopes has delayed the secondary succession of these areas. General Land Office Survey records from 1850 (available at the Lands Division of the Michigan Department of Natural Resources, Lansing) show that the presettlement forests at these sites were predominantly sugar maple, beech, and hemlock with scattered oak, pine, and aspen.

Crystal River Area

The Crystal River, its source in Big Glen Lake, enters the National Lakeshore after flowing under Fisher Road, flows over a dam, and meanders about two miles across the corrugated lake plain before leaving the Lakeshore. The river is narrow, but navigable by canoe. Eventually it flows under County Road 675, makes one short 1/4 mile bend before swinging by this road, and leaves the National Lakeshore. The surrounding vegetation is largely coastal forest, but some swales and cedar swamps are found along the river especially at the bends. Blunt-leaved orchid and broad-leaved twayblade (*Listera convallarioides*) occur locally in these cedar swamps. In the Crystal River itself, submerged and floating aquatics include elodea, duckweed, water-milfoil, naiad, water-lily, pondweeds, bladderworts, and tape-grass. Shoreline herbs include Indian-hemp (*Apocynum cannabinum*), swamp milkweed, blue-joint (*Calamagrostis canadensis*), marsh marigold, marsh bellflower, sedges, spike-rushes, water horsetail (*Equisetum fluviatile*), joe-pye-weed, touch-me-not, southern blue flag, rushes, marsh pea (*Lathyrus palustris*), cardinal flower, Kalm's lobelia, bugle-weed, square-stemmed monkeyflower (*Mimulus ringens*), true forget-me-not (*Myosotis scorpioides*), sensitive fern, royal fern, grass-of-parnassus, duck-potato, bulrush, common skullcap, mad-dog skullcap, nightshade, and marsh fern. Shrubs include Kalm's St. John's-wort, sweet gale, swamp rose, and willows.

Not far from the Crystal River to the northeast is a *Sphagnum* bog which is readily observed from M-22 east of Westman Road. At the southern end of the bog is open water, ringed by swamp loosestrife, in which are pond-lily and bladderwort (*Utricularia geminiscapa*). The rest of the bog is dominated by leather-leaf. Other shrub species here include bog-rosemary, huckleberry, bog-laurel (*Kalmia polifolia*), Labrador tea (*Ledum groenlandicum*), and velvet-leaf blueberry. The trees scattered through the bog are mainly white pine and tamarack. Dwarf mistletoe (*Arceuthobium pusillum*)

is found as a parasite on black spruce, now most common in the understory. Along the bog moat on the southwest side, mountain holly (*Nemopanthus mucronatus*), Michigan holly, and white birch are common. Herbaceous species throughout the bog include *Carex trisperma*, stemless lady-slipper, sundew, cotton-grass, creeping snowberry, white-fringed orchid (*Habenaria blephariglottis*), pitcher-plant, three-leaved false Solomon's seal, and small cranberry (*Vaccinium oxycoccos*). Indian pipe (*Monotropa uniflora*) even occurs on *Sphagnum* hummocks.

Pyramid Point Area

Another bog-like area occurs south of Pyramid Point near Port Oneida northeast of the intersection of Port Oneida and Kelderhouse roads. Vegetation here is quite dense, making the area harder to explore than the M-22 bog. This area is important because a few species have been found nowhere else in the National Lakeshore. Such species include rose pogonia (*Pogonia ophioglossoides*), bartonia (*Bartonia virginica*), and a rare pondweed, *Potamogeton oakesianus*, as well as four sedges (*Carex* spp).

The region north of this bog is easily explored via the Pyramid Point trail system. Parking is available at the trailhead off Basch Road. The trail passes through an old field before entering the woods. In the fall, the autumn coral-root (*Corallorhiza odontorhiza*) is easily found at the woods/field border. The trail forks after entering the woods, splitting into uphill and downhill routes.

The uphill route leads to an overlook at the Pyramid Point bluffs. On a clear day North and South Fox islands, 30 miles to the north, are visible. This vantage also provides an excellent view of South Manitou, North Manitou, and the lake bluffs toward Leland. A rough trail to the east of this overlook leads to the perched dunes.

The downhill route from the fork brings one to the advancing dune front of the perched dunes. Among the herbs in the woods here are puttyroot (*Aplectrum hyemale*) and yellow lady-slipper. Farther down the trail, at the base of the wooded bluff, are northern holly fern (*Polystichum lonchitis*) and nodding trillium (*Trillium cernuum*).

To the north, lying just to the east of the perched dunes at Pyramid Point, is Hidden Lake. The open water, just over two acres, is surrounded by white cedars. At the south end is a well developed cedar swamp. The most notable vascular plant species here is the showy lady-slipper (*Cypripedium reginae*) on the lake's west side.

Shalda Creek/Good Harbor Bay Area

Shalda Creek leaves Little Traverse Lake and flows about 1/4 mile west before entering Sleeping Bear Dunes National Lakeshore. After another 1/4 mile it flows under County Road 669 and after two more miles eventually flows into Lake Michigan. Beyond County Road 669 it enters the moist

coastal forest after the creek passes between a cedar swamp and a small marsh dominated by common cat-tail.

The cedar swamp has an overstory of balsam fir, white birch, black ash, tamarack, black spruce, and white cedar. Understory species include balsam fir, striped maple, red maple, alder, and white cedar. The herb layer is diverse. Ferns include lady fern, rattlesnake fern, crested shield fern, oak fern, sensitive fern, cinnamon fern, royal fern, and marsh fern. Among the other herbs are white baneberry (*Actaea pachypoda*), spikenard (*Aralia racemosa*), jack-in-the-pulpit, swamp milkweed, big-leaved aster, marsh marigold, marsh bellflower, sedges, dwarf enchanter's nightshade, corn-lily, goldthread, helleborine (*Epipactis helleborine*), creeping snowberry, water avens, tall northern bog orchid (*Habenaria hyperborea*), long-bracted green orchid (*Habenaria viridis*), touch-me-not, twinflower, tufted loosestrife, Canada mayflower, partridgeberry, naked miterwort, heal-all, hooked crowfoot (*Ranunculus recurvatus*), three-leaved false Solomon's seal, deadly nightshade, and starflower.

As Shalda Creek nears Lake Michigan it becomes deeper and begins to wander among low dune ridges. Large swales have formed between the dune ridges adjacent to the creek. The dune ridges are dominated by red maple, white birch, quaking aspen, and red oak. Shrubby vegetation of the swales includes alder, silky dogwood, red osier, sweet gale, shrubby cinquefoil, swamp rose, and willows. Herbs include blue joint, marsh bellflower, sedges, water-hemlock, *Cinna latifolia*, joe-pye-weed, boneset, southern blue flag, cardinal flower, bugle-weed, tufted loosestrife, *Mentha arvensis,* square-stemmed monkeyflower, water cress, sensitive fern, royal fern, Virginia creeper (*Parthenocissus quinquefolia*), *Proserpinaca palustris*, duck-potato, common skullcap, *Sparganium minimum*, and marsh fern.

The flora of the open dunes along Good Harbor Bay is very similar to that of the coastal dunes of the rest of the Lakeshore. The transition zone between the open dunes and oak-pine woods, however, provides suitable habitat for pine-drops (*Pterospora andromedea;* Fig. 6), a species listed as threatened in Michigan (MDNR 1989). The main range for this saprophyte is in the West with disjunct populations in the Great Lakes and St. Lawrence regions. In Michigan it occurs in shoreline areas and is known for its infrequent occurrence and variable abundance from year to year.

BOW LAKES UNIT

The Bow Lakes unit is among the most botanically rewarding areas within the National Lakeshore. The area's physiography is dominated by a valley, formed when ice melted within the glacial deposits, which runs from north to south for almost two miles. The lowest areas of the resulting depression have accumulated water. At present there are no Park Service parking areas, so best access to the Bow Lakes unit is either from the south end via Baatz Road, or from the west via Lanham Road. (Persons interested in finding these roads should consult county road maps.)

FIGURE 6. Pine-drops (*Pterospora andromedea*).

The valley is predominantly vegetated by northern hardwood forests which rank among the richest in the National Lakeshore. The overstory is largely sugar maple, basswood, white ash, American elm (*Ulmus americana*) and ironwood. Among the dominant understory species are sugar maple, ironwood, witch-hazel, wild gooseberry (*Ribes cynosbati*), and leatherwood (*Dirca palustris*). Compared to the rest of the National Lakeshore, leatherwood is abundant here. The herbs are diverse and profuse.

Some small ponds are scattered throughout the valley, but the major aquatic sites are at its opposite ends. At the north end are the Bow Lakes, two small ponds connected by a narrow channel. South of these ponds is a spring-fed area with an extensive sedge mat. At the opposite end of the Bow Lakes unit is a *Sphagnum* bog dominated by leatherleaf. Other species include bog-rosemary, chokeberry, sundew, bog-laurel, bog arrow-grass (*Scheuchzeria palustris*), small cranberry, and *Viola blanda*. A few small openings remain near the center of the mat with cotton-grass, *Juncus brevicaudatus*, water smartweed, and *Utricularia geminiscapa*. A moat around the bog fills with water in wet years.

MANITOU ISLANDS

The Manitou Islands are presently accessible by passenger ferry from Leland. During the 19th century, ships made regular stops on the islands to take on cordwood fuel or, especially on South Manitou, to seek shelter from storms. Similar to the mainland, the islands are glacial deposits, which in places have been modified by winds and the action of Lake Michigan and its ancestral lakes.

South Manitou

This island covers 5,260 acres (21.2 km^2) and lies about 7 miles northwest of Sleeping Bear Point, the nearest mainland. On the island's west side, perched dunes cover parts of moraine. On the east side, moraine gives way to lake plain. A deep crescent-shaped bay on the island's east side is bounded by Gull Point on the north and Sandy Point on the south. Lake Florence is the only inland lake.

Around 1835, William Burton organized a cordwood supply operation on South Manitou (Vent 1973) along the bay. Later the settlement of Garden City grew at the end of Chicago Road, on the west side of the bay. By 1847, as noted by Orange Risdon, General Land Office surveyor, almost half the island, predominantly on the lake plain as far as the west side of Lake Florence, was cut over. In his survey, Risdon did not mention the dunes on the island's north side. Perhaps this dune activity occurred as a result of later lumbering activity. The most recent logging on the island occurred on state land west of Lake Florence in 1964.

After early logging, the land was cleared further by farming families, who also planted orchards. The island's isolation aided in the development of

prize-winning strains of Rosen rye in the 1920s. Later a strain of beans was developed on the island. Farming declined in the 1930s with the increasing difficulty of getting produce to market as fewer ships stopped at the island.

The modern-day traveller usually arrives on South Manitou at the former Coast Guard station and village area situated at the south side of the bay. Botanists exploring the low, irregular coastal dunes of the bay will find the flora to be similar to other dunes in the National Lakeshore. Holboell's mustard (*Arabis holboellii*), a species whose main range is in the Rocky Mountains, however, is more common on the coastal dunes of the Manitou Islands than on the Lakeshore's mainland. At Gull Point the flora of the gull colony has several species generally not associated with coastal dunes. These include downy chess (*Bromus tectorum*), English plantain (*Plantago lanceolata*), sulfur cinquefoil, hedge mustard (*Sisymbrium altissimum*), common chickweed (*Stellaria media*), and field pansy (*Viola arvensis*). These alien species probably thrive here due to the modification of the soil resulting from the presence of the gulls.

Among the species in the transition zone between the coastal dunes and the coastal forest are ram's-head lady-slipper, one-flowered wintergreen (*Moneses uniflora*), and calypso or fairy-slipper (*Calypso bulbosa*). Calypso (Fig. 7), listed as threatened in Michigan (MDNR 1989), has recently been found near the Garden City cemetery and other sites in the coastal forest along the bay. Previous island residents, however, remember it occurring in the coastal forest near the lighthouse in the 1920s.

The coastal forest on the lake plain of the island's east side is a diverse mixture of conifers and deciduous trees occurring on a series of concentric ridges which formed as higher Lake Michigan levels receded. Drier sites are dominated by white pine, jack pine, and red pine. Some of the troughs retain moisture throughout the year and in moister sites balsam fir, white cedar, quaking aspen, and hemlock are common. Occasionally beech, sugar maple, or red oak are found. Common understory species include red maple, yew, white birch, and balsam fir.

The northern hardwood forests, generally found west of the coastal forest, are predominantly composed of sugar maple, beech, white ash, basswood, and hemlock. Unlike the mainland and North Manitou, black cherry is rare on South Manitou. Understory species include red elderberry, maple-leaved viburnum, yew, wild gooseberry, and saplings of overstory species.

From a botanical standpoint, South Manitou is best known for The Cedars, a small grove of giant white cedars in the southwest corner of the island. This area may have developed when lee slopes of dunes encroaching on hardwood stands were colonized by white cedar (Scott & Murphy 1986). Today the National Champion white cedar (173 cm dbh; 549 cm circ.) occurs here (Thompson 1986). In addition to white cedar, the area is shadowed by sugar maple and white ash. At one time white cedar had a greater cover value here, but it has been gradually replaced by deciduous species. Several white cedar stumps in the woods along the trail to the Cedars indicate that the grove was much larger in area. Theories regarding the survival of the present collection of cedars include the presence of sand in

FIGURE 7. Calypso (*Calypso bulbosa*).

the wood which dulled saw blades, the difficulty of bringing the logs out, and the sentimental preservation of the largest trees by lumbermen. The truth probably lies closer to economic rather than emotional reasons.

In addition to the size of the white cedars, the average visitor to the Cedars is also impressed with the size and profusion of understory species. Such species include bishop's cap, naked miterwort, Canada violet, early meadowrue, false spikenard (*Smilacina racemosa*), jack-in-the-pulpit, maidenhair fern (*Adiantum pedatum*), rattlesnake fern, white baneberry, red baneberry (*Actaea rubra*), sharp-leaved hepatica, Solomon's seal, spikenard, sweet cicely, wild leeks, yellow lady-slipper, and zig-zag goldenrod. Of special interest are northern holly fern, green spleenwort (*Asplenium viride*), and walking fern (*Camptosorus rhizophyllus*), calciphilic ferns occurring here despite the absence of limestone outcrops. Green spleenwort

is found on the sandy forest floor. Walking fern, however, usually occurs on mossy cedar logs, but sometimes grows on an adjacent dune bank. The common trillium, wake robin (*Trillium erectum*), and drooping trillium (*Trillium flexipes*) occur together here and are believed to hybridize. The presence of drooping trillium is noteworthy because it is a predominantly southern species.

The most extensive dunes on South Manitou are the perched dunes on the island's west side. The flora is similar to the perched dunes of the Sleeping Bear Plateau, although the appearance of these dunes is more natural due to their remoteness. An excellent view of the Sleeping Bear Point and the rest of South Manitou are among the rewards for those who trek to this isolated portion of the island.

One vegetation association not found on the Lakeshore's mainland portion is the small band of northern conifers occurring on the steep, dune-exposed slopes bordering the east edge of the open perched dunes. Characteristic overstory species of this conifer forest include a dense growth of white cedar, balsam fir, and white birch with an occasional white spruce (*Picea glauca*). Such lake-exposed sites on the Manitou Islands are the only locations for naturally occurring white spruce in the National Lakeshore. Understory species of the northern conifers include yew, red elderberry, and mountain maple with some wild honeysuckle, fly honeysuckle, round-leaved dogwood, pagoda dogwood, maple-leaved viburnum, and snowberry (*Symphoricarpos albus*).

Throughout the island are old fields in various stages of secondary succession. Unlike most fields in the mainland portion of the National Lakeshore which are largely colonized by saplings from the surrounding woods, many of the older fields on South Manitou are dominated by common and trailing junipers. Perhaps this trend is due to the absence of deer on the island. Scattered throughout the older fields are also pin cherry (*Prunus pensylvanica*), choke cherry, white birch, and some quaking aspen.

Lake Florence (72 acres), in the center of the island, was named for Florence Haas, a South Manitou islander who, according to island lore, was the first woman on the Great Lakes with a pilot's license. Marshes occur at both ends of the lake. The larger, on the north end, continues north into the narrow basin west of the schoolhouse. The lake has no inlet or outlet and its level varies from year to year according to annual precipitation. Submerged and floating aquatic species are limited to pondweeds. Among the noteworthy species around the edges of this lake and in its associated wetlands are fen orchid (*Liparis loeselii*), creeping spearwort (*Ranunculus reptans*), purple-fringed orchid (*Habenaria psycodes*), germander (*Teucrium canadense*), meadowsweet (*Spiraea alba*), and swamp candle (*Lysimachia terrestris*).

North Manitou

This island covers 14,753 acres (59.8 km^2). It lies 3.5 miles northeast of South Manitou, and 7 miles north of Pyramid Point, the nearest mainland. The island is largely moraine with some glacial outwash. Due to a wind

shadow created by South Manitou, active dunes are limited to the island's southwest and southeast corners and to some perched dunes on the northwest side. Tamarack Lake and Lake Manitou are the major aquatic and wetland habitats. Some wetland species also occur on the west side at the site of the settlement of Crescent in a low depression near the former location of the lumber mill and dock.

In 1846 Nicholas Pickard began supplying cordwood on North Manitou, centered near the cove north of the island's southeast corner. A year later, General Land Office Survey notes show that timber cutting had only extended about 1/2 mile west, and north along the coast to an area near the present site of North Manitou Village. Soon thereafter the wood-supplying port of Aylesworth was settled on the west side (Fritz 1986). This settlement grew into the town of Crescent after the Smith & Hull Lumber Company leased land in 1906 for a sawmill and dock. Logs were delivered to the sawmill by narrow gauge railroad until the end of this venture in 1915. Commercial logging on the island was revived in 1956 and continued until 1978 (Rusco 1991).

Visitors arriving on North Manitou by ferry usually land at the village of North Manitou. This area was the island headquarters of the Manitou Island Association for its commercial operations such as hunting, fruit production, and logging. Boat docking facilities were not as protected as on South Manitou, thus the long airstrip near the village was constructed to assure accessibility to the island.

Some fields scattered across the islands denote old homesteads and lumber camps; the largest mark the sites of previous settlements. Farming on the island was not as extensive as on South Manitou, perhaps in part, owing to less level ground. Orchards were common. The open areas on North Manitou, however, do not show the same degree of secondary succession as those on South Manitou. Native woody species are generally restricted to a few individuals of rose or juniper.

The majority of the island is covered by northern hardwood forests composed predominantly of sugar maple, beech, black cherry, basswood, and white ash. Secondary associates include white birch, yellow birch, hemlock, and big-tooth aspen. Red oak is most abundant in the woods north of the airstrip and near the tops of hills on the island's east side. Overstory species of forests occurring on a small lake plain on the island's east side are an irregular mix of white pine, red maple, white birch, and hemlock with scattered sugar maple, white cedar, balsam fir, and red oak.

In most of the northern hardwood forests the herbs are widely scattered and understory is limited, allowing one to see far into the woods. The unnatural park-like appearance of these forests, first noted in the 1940s by the Michigan DNR, can be attributed to a white-tail deer population established on the island in the 1920s. Today a browse-line about six feet high is readily visible at the edges of fields and along shorelines. Secondary succession of the fields is very limited. A deer exclosure built in the early 1960s on an open site in the forest west of the outlet of Lake Manitou near the Pole Bridge is now packed with herbs, saplings, and a few small trees. The cedar

swamps at the ends of Lake Manitou noted by the General Land Office Survey in 1847 and described by Coulter (1904) are gone. Some species such as yew, false spikenard, bellwort, staghorn sumac, blue cohosh, bush honeysuckle, fly honeysuckle, wild honeysuckle, maple-leaved viburnum, highbush cranberry, round-leaf dogwood, bearberry, white baneberry, dune cherry, buffaloberry, and cow-parsnip, common on South Manitou which has no deer, are either rare or apparently absent on North Manitou. Public hunting has been permitted each fall since 1985. Perhaps in time the vegetation will improve after having some relief from the deer herbivory.

In the woods south of the Frank Farm (about 1 mile west of North Manitou Village) is a group of nine American chestnuts (*Castanea dentata*), a few with multiple trunks. This healthy stand was probably established by an island farmer earlier in this century. Such planting was common, attested by the regular occurrence of chestnuts at the sites of old farms and orchards along Lake Michigan (Brewer 1982). Most of the surrounding trees of this stand are big-tooth aspen, but other overstory species include sugar maple, black cherry, beech, and ironwood.

Tamarack Lake, near the island's west side, occupies almost 10 acres. Familiar bog species such as leatherleaf, huckleberry, bog-laurel, tamarack, black spruce, and velvet-leaf blueberry are found on the east side. Here too is a very narrow sedge mat with water-hemlock, sundew, three-way sedge (*Dulichium arundinaceum*), touch-me-not, southern blue flag, rushes, tufted loosestrife, cinnamon fern, reed, marsh cinquefoil, swamp rose, marsh fern, marsh St. John's-wort, and small cranberry in addition to sedges. Pond-lily is the lake's only aquatic species. The lack of development of the mat suggests that its formation has not kept pace with the advance of the bordering shrub zone. On the lake's west side a spring-fed stream flows into the black ash swamp composed of widely scattered black ash with some yellow birch, white cedar, and red maple.

Similar black ash swamps occur at both ends of Lake Manitou, the largest lake in the National Lakeshore (252 acres), in the north central portion of the island. In wet years, the shallow outlet flows northeast to Lake Michigan first through the black ash swamp, then through a sedge-dominated marsh until reaching the Pole Bridge where it enters northern hardwoods. Among the floating and submerged aquatics of Lake Manitou are water-milfoil, naiad, water-lily, pondweeds, and white water crowfoot.

CATALOG OF VASCULAR PLANTS

The majority of the fieldwork on which this catalog is based was carried out from 1982 to 1987 as part of three studies on the vegetation and flora of Sleeping Bear Dunes National Lakeshore (Hazlett & Vande Kopple 1983; Hazlett 1986, 1989). I also searched the herbaria at the Missouri Botanical Garden (MO), Cranbrook Institute of Science (BLH), and William R. Overlease's personal herbarium for specimens from the National Lakeshore col-

lected by others, and consulted records used in the preparation of Michigan Flora, Parts 1 and 2 (Voss 1972, 1985).

More than 40 botanists, including Paul W. Thompson in Leelanau Co. and William R. Overlease in Benzie Co. (Overlease & Overlease 1985a, 1985b, 1985c, 1985d), are known to have made vascular plant collections within the region encompassed by Sleeping Bear Dunes National Lakeshore. I have not attempted to cite all of these collectors and their collections in this catalog. One exception to this practice is the citation of a few noteworthy *Botrychium* collections made by Warren H. Wagner. Usually only numbers made by the most prolific collectors for the Manitou Islands (Engelmann, Thompson, Voss, and Wislizenus) and the mainland portion of the National Lakeshore (Overlease, Thompson, and Voss) have been cited in addition to my own unless the only collection of a given species was made by someone else. I have attempted to examine all specimens cited except for those recorded by Voss in the production of Michigan Flora (1972, 1985). Main herbaria for the cited collectors are as follows: BLH, Thompson; University of Illinois (ILL), Cowles; University of Michigan (MICH), Funk, Reznicek, Voss, Wagner; MO, Engelmann, Wislizenus; Ohio State University (OS), Transeau; personal herbarium, Overlease.

Unless another collector is noted, all numbers represent my collections of which most (90%) have been deposited at MICH. The other 10% (unicates of taxa supported by other numbers at MICH) have been deposited in herbaria (listed in decreasing number of specimens) at Sleeping Bear Dunes National Lakeshore, Lakehead University (LKHD), University of Waterloo (WAT), University of Michigan Biological Station (UMBS), and Michigan State University (MSC).

Nomenclature and common names for the following list of 107 families, 395 genera, 904 species, and 11 hybrids generally follows Lellinger (1985) for ferns and fern allies, and Gleason and Cronquist (1963) for those groups not covered by Voss (1972, 1985). Common names for some species also follows Peterson & McKenny (1968). Synonomy for orchids follows Case (1987). The distribution of species and hybrids within Sleeping Bear Dunes National Lakeshore is noted by the following abbreviations; **M**, Mainland; **S**, South Manitou; **N**, North Manitou. Abundance estimates, based on field observations and collections, follow the scale described in Voss (1972, p. 24). The following abbreviations are used: **C**, common; **F**, frequent; **O**, occasional; **L**, local; **R**, rare. Future investigations may show species now listed as local or rare to be more common.

The families within the four major groups, and then the species within each family, are listed in alphabetical order. Common names, where known, have also been included. The largest family, the Cyperaceae, is represented by 88 species. *Carex*, the largest genus, has 65 species. Among the species in the flora of Sleeping Bear Dunes National Lakeshore are ten listed as threatened and six as of special concern by the State of Michigan (MDNR 1989). The threatened species are the Sleeping Bear dunewort (*Botrychium campestre*), western moonwort (*B. hesperium*), Pumpelly's brome grass (*Bromus pumpellianus*), calypso (*Calypso bulbosa*), Pitcher's

thistle (*Cirsium pitcheri*), Michigan monkey-flower (*Mimulus glabratus var. michiganensis*), broom-rape (*Orobanche fasciculata*), ginseng (*Panax quinquefolius*), pine-drops (*Pterospora andromedea*), and three-birds orchid (*Triphora trianthophora*). Special concern species are green spleenwort (*Asplenium viride*), walking fern (*Camptosorus rhizophyllus*), water-parsnip (*Berula erecta*), *Carex concinna*, spotted wintergreen (*Chimaphila maculata*), and ram's-head lady-slipper (*Cypripedium arietinum*). Pitcher's thistle, a Great Lakes endemic, is also federally listed as threatened.

The taxonomic status of some plants occurring within the area covered by this paper has yet to be completely sorted out. The discovery of the dunewort has prompted Drs. Warren H. and Florence S. Wagner to focus on Sleeping Bear region in their studies of the genus *Botrychium*. On a field trip with me to South Manitou in 1985, they found the first lower Michigan record of *B. hesperium*, a Western species. Examination of collections from this and subsequent trips to Sleeping Bear has convinced them that at least two new *Botrychium* species (*B. pallidum and B. spathulatum*) occur in this region (Wagner & Wagner 1990).

A second problem is the identification of *Trillium* in the Cedars on South Manitou, especially the distinction between *T. flexipes* and *T. erectum* var. *alba*. Thomas S. Patrick, University of Tennessee, determined that *T. flexipes* and a hybrid (*T. erectum* L. × *T. flexipes* Raf.) occur on the island based on examination of herbarium specimens made by Paul W. Thompson and Edward G. Voss. During a Michigan Botanical Club field trip there in 1984, Tony Reznicek stated his belief that *T. flexipes* grew in the Cedars. Voss, on the other hand, after examining my collections and some annotated by Patrick is not convinced of a difference, other than color, between the red-flowered *T. erectum* and the white-flowered "*T. flexipes*". For the moment he considers his *9905* and my *3911, 3087, 3912, 3913* to be *T. erectum* or hybrid. My treatment of *Trillium* includes *T. flexipes*, although Patrick has not seen my specimens. Ultimately the solution to this problem will be solved by fieldwork by *Trillium* experts.

CHECKLIST OF VASCULAR PLANTS

(**M**ainland, **S**outh Manitou, **N**orth Manitou)
(**C**ommon, **F**requent, **O**ccasional, **L**ocal, **R**are)

PTERIDOPHYTES

EQUISETACEAE (Horsetail Family)

Equisetum arvense L., Field Horsetail (M, S, N). (C) Dunes, old fields, roadsides, and some woods. *1382, 1523, 1571, 3035, 3609, 3619, 3650, 4047.*

E. ×*ferrissii* Clute (M, S). (L) Old fields and roadsides. *3214, 3230.*

E. fluviatile L., Water Horsetail (M, N). (O) Wet thickets and swales. *3438, 4061a, 4144.*

E. hyemale L., Scouring-rush (M, S, N). (C) Dunes, shores, and old fields. *1311, 1559, 1720, 2832, 3250, 3499, 3536, 3643, 4171, 4338, 4569; Engelmann.*

E. scirpoides Michaux, Dwarf Scouring-rush (M, N). (O) Wet woods and cedar swamps. *1692, 3274, 4379, 4450.*

E. sylvaticum L., Woodland Horsetail (M, N). (L) Cedar swamp along Otter Creek and black ash swamps along Lake Manitou. *1642, 3614, 4510.*

E. × *trachyodon* A. Braun, (M). (L) Dune pools and jack pine stands. *3479, 4067, 4675.*

E. variegatum Schleich. ex Fried. Weber & Mohr, (M, S). (F) Dunes, dune pools, and jack pine stands. *3493, 4081, 4239, 4327, 4441.*

LYCOPODIACEAE (Clubmoss Family)

Lycopodium annotinum L., Stiff Clubmoss (M, S, N). (F) Coastal forests. *1664, 2516, 3039, 3595, 4280; Engelmann; PWT L-1842; EGV 5132.*

L. clavatum L., Running Clubmoss (M, S, N). (F) Coastal forests. *1666, 1796, 3452, 3503, 3593, 3620, 4374; PWT L-952; EGV 5133; Wislizenus 1023.*

L. complanatum L., Northern Running-pine (M, S, N). (O) Coastal forests. *2756, 3596, 4560.*

L. dendroideum Michaux, Round-branch Ground-pine (M, S). (F) Coastal forests. *3210, 3280.*

L. lucidulum Michaux, Shining Clubmoss (M, S). (O) Cedar swamps and some northern hardwoods. *1732, 2789, 3600, 3616.*

L. obscurum L., Tree Clubmoss (M, S, N). (F) Coastal forests and some northern hardwoods. *1233, 1665, 2080, 2129, 3270, 4559.*

L. tristachyum Pursh, Ground-cedar (M, S). (F) Coastal forests and old fields. *1911, 2698, 3670, 4309, 4375, 4733.*

L. × *zeilleri* (Rouy) Beitel, (N). (L) Woods/field edge, North Manitou. *1663.*

SELAGINELLACEAE (Selaginella Family)

Selaginella rupestris (L.) Spring, Rock Spikemoss (M). (L) Open sandy areas along Peterson Rd., near Bass Lake (Benzie Co.), and along Good Harbor Bay. *2938, 3037; WRO 2471.*

OPHIOGLOSSACEAE (Adder's Tongue Family)

Botrychium campestre W.H. Wagner & Farrar, Dunewort (M, S). (O) Perched dunes or sand originating from such dunes. *3028, 3184, 3193; WHW 85024, 85025, 85026, 85030, 85035.* Michigan threatened species.

B. dissectum Sprengel, Dissected Grape Fern (M, S). (O) Old fields and young woods. *2693, 3602, 4731; WHW 85032.*

B. hesperium (Maxon & R.T. Clausen) W.H. Wagner & Lellinger, Western Moonwort (S). (R) Old field at site of Garden City, South Manitou. *4205.* Michigan threatened species.

B. lunaria (L.) Sw., Moonwort (M, S). (L) Old field along Empire Bluffs trail; protected sites on perched dunes of South Manitou and old field at site of Garden City. *3261; WHW 85029, 85036.*

B. matricariifolium A. Braun, Daisy-leaved Moonwort (M, S, N). (C) Old fields and northern hardwoods. *1895, 2323, 2338, 2387, 3164, 3172, 3189, 3192, 3194, 3231, 3266b, 3598, 4118, 4168, 4170, 4303, 4319, 4561; WHW 85034, 85038.*

B. minganense Vict., Mingan Moonwort (M, S). (L) Old field along Empire Bluffs trail; protected sites on perched dunes of South Manitou and old field at site of Garden City. *3054, 3260, 3267.*

B. multifidum (Gmelin) Rupr., Leathery Grape Fern (M, S, N). (O) Young woods and old fields. *1856, 1993, 3529, 4494, 4553.*

B. pallidum W. H. Wagner (S). (R) Old field at site of Garden City. *WHW 85037.*

B. simplex Hitchc., Least Moonwort (M, S). (O) Edges of old fields. *3215, 3232, 3266a, 3405; WHW 85031, 85039.*

B. spathulatum W. H. Wagner (M, S). (R) Base of dunes north of old Scenic Drive entrance; protected sites on perched dunes of South Manitou. *WHW 85027, 86104.*

B. virginianum (L.) Sw., Rattlesnake Fern (M, S, N). (C) Northern hardwoods, cedar swamps, and young woods. *1512, 2829, 2838, 4154.*

Ophioglossum pusillum Raf., Adder's Tongue (M, S). (O) Moist fields; moist lawn along Platte River. *3212, 3402, 3578, 4176.*

OSMUNDACEAE (Royal Fern Family)

Osmunda cinnamomea L., Cinnamon Fern (M, N). (F) Swales, bogs, cedar swamps, and black ash swamps. *1677, 2274, 2570, 3512.*

O. claytoniana L., Interrupted Fern (M, N). (O) Wet woods. *1854, 3518, 3667.*

O. regalis L., Royal Fern (M, S, N). (O) Swales and cedar swamps. *1583, 2571, 2870, 4141.*

POLYPODIACEAE [*Sensu lato*] (Fern Family)

Adiantum pedatum L., Maidenhair Fern (M, S, N). (F) Northern hardwoods. *1696, 1770, 2744, 2792.*

Asplenium platyneuron (L.) BSP., Ebony Spleenwort (M, S). (L) Old fields along Empire Bluffs trail, Scenic Drive, and on South Manitou. *1544, 3406.*

A. viride Hudson [*A. trichomanes-ramosum* L.], Green Spleenwort (S). (R) Forest floor of giant cedar grove on South Manitou. *1896.* Michigan special concern species.

Athyrium filix-femina (L.) Roth, Lady Fern (M, S, N). (F) Cedar swamps, northern hardwoods, and some swales. *1803, 1816, 2865, 4122; PWT L-1555a; Wislizenus 672.*

A. pycnocarpon (Sprengel) Tidestrom, Glade Fern (M). (O) Rich northern hardwoods and a black ash swamp at Shell Lake. *2971, 4788.*

A. thelypterioides (Michaux) Desv., Silvery Glade Fern (M). (L) Rich northern hardwoods. *2972, 3540.*

Camptosorus rhizophyllus (L.) Link [*Asplenium rhizophyllum* L.], Walking Fern (S). (R) Mossy logs of giant cedar grove on South Manitou. *1726; PWT L-2181; EGV 9887.* Michigan special concern species.

Cystopteris bulbifera (L.) Bernh., Bulblet Fern (M, S, N). (F) Moist northern hardwoods. *1605, 1872, 4409; Wislizenus 677.*

C. tenuis (Michaux) Desv., Fragile Fern (M, N). (O) Northern hardwood-shaded bluffs and banks. *1608, 2791, 3645, 4182.*

Dryopteris clintoniana (D. C. Eaton) Dowell, Clinton's Wood Fern (M). (L) Black ash swamp along North Bar Lake. *4238.*

D. cristata (L.) A. Gray, Crested Shield Fern (M, N). (O) Bogs and cedar swamps. *1837, 2820, 3219, 3625, 4437.*

D. intermedia (Muhlenb.) A. Gray, Evergreen Wood Fern (M, S, N). (F) Northern hardwoods. *1644, 1859, 4115, 4784; PWT L-968; WRO 2826; EGV 5134.*

D. marginalis (L.) A. Gray, Marginal Wood Fern (M, S, N). (C) Northern hardwoods. *1690, 2742, 2787, 4116; PWT L-928; Wislizenus 676.*

D. ×*slossonae* Wherry, (M). (L) Cedar swamp at Marl Springs. *4451.*

D. spinulosa (Mueller) Watt [*D. carthusiana* (Villars) H. P. Fuchs], Spinulose Wood Fern (M, S, N). (F) Northern hardwoods. *1906, 2692, 4051, 4123.*

D. ×*triploidea* Wherry, (M, S, N). (O) Northern hardwoods. *1835, 3946, 4114.*

D. ×*uliginosa* (A. Braun) Druce, (M). (L) Cedar swamp at Marl Springs. *4438.*

Gymnocarpium dryopteris (L.) Newman, Oak Fern (M, N). (O) Northern hardwoods and black ash swamps. *1621, 4231; PWT L-1564.*

Matteuccia struthiopteris (L.) Todaro, Ostrich Fern (M, S, N). (O) Wet woods and black ash swamps. *1680, 1858, 2927, 4750.*

Onoclea sensibilis L., Sensitive Fern (M, S, N). (F) Wet woods and cedar swamps. *1676, 1860, 2869.*

Polypodium virginianum L., Common Polypody (M, S, N). (O) Northern hardwood-shaded banks, and wooded dunes near Aral. *1235, 1688, 2837; PWT L-1844.*

Polystichum acrostichoides (Michaux) Schott, Christmas Fern (S). (L) Northern hardwoods near shipwreck overlook on South Manitou. *1561.*

P. braunii (Spenner) Feé, Braun's Holly Fern (S). (L) Northern hardwoods, South Manitou. *1867; EGV 9895.*

P. lonchitis (L.) Roth, Northern Holly Fern (M, S, N). (L) Base of northern hardwood-

shaded bluff near Hidden Lake, giant cedar grove on South Manitou, and Pot Holes on North Manitou. *1574, 1695, 3906; PWT L-1849; EGV 9904.*

Pteridium aquilinum (L.) Kuhn, Bracken Fern (M, S, N). (C) Oak-pine woods, old fields, and dunes. *1598, 1910, 4726; Wislizenus 670.*

Thelypteris hexagonopteris (Michaux) Weath., Broad Beech Fern (M). (L) Northern hardwoods west of Round Lake. *2978.*

T. palustris Schott, Marsh Fern (M, S, N). (C) Cedar swamps and edges of lakes and streams. *1675, 1757, 2866, 3505; PWT L-1575.*

T. phegopteris (L.) Slosson, Northern Beech Fern (N). (L) North Manitou in northern hardwoods south of, and in black ash swamp north of, Lake Manitou. *1645, 4546.*

Woodwardia virginica (L.) Smith, Virginia Chain Fern (M). (L) Swampy woods along both Miller and Westman roads. *2818.*

GYMNOSPERMS

CUPRESSACEAE (Cypress Family)

Juniperus communis L., Common Juniper (M, S, N). (C) Old fields and dunes. *3932, 4169; WRO 113; PWT L-71; EGV 5147, 9874; Wislizenus 597.*

J. horizontalis L., Creeping Juniper (M, S, N). (F) Old fields and dunes. *1514, 1964, 3931; Engelmann; WRO 103; PWT L-56, L-736; EGV 5148, 9875.*

Thuja occidentalis L., White Cedar (M, S, N). (C) Cedar swamps, swales, jack pine stands, and edges of dunes. *1609, 1894, 2830, 3504; EGV 9876; PWT L-57; Wislizenus 1001.*

PINACEAE (Pine Family)

Abies balsamea (L.) Miller, Balsam Fir (M, S, N). (C) Cedar swamps and edges of dunes. *1617, 1927, 4727; WRO 455, 636; PWT L-66, L-278; Wislizenus 1000.*

Larix laricina (Duroi) K. Koch, Tamarack (M, N). (F) Bogs and cedar swamps. *1415, 2425; PWT L-579.*

Picea glauca (Moench) A. Voss, White Spruce (S, N). (O) Naturally occurring on Lake Michigan-facing slopes of Manitou Islands. *1308, 1691, 1873.*

P. mariana (Miller) BSP., Black Spruce (M, N). (O) Bogs and some swales. *2702, 3449, 4763; PWT L-578.*

Pinus banksiana Lambert, Jack Pine (M, S). (C) Dunes, jack pine stands, and coastal forests. *1903, 2061, 3930; WRO 106, 560; PWT L-570, L-1683; EGV 9873.*

P. resinosa Aiton, Red Pine (M, S, N). (C) Coastal forests and jack pine stands. *1909, 1982, 3474, 3929; WRO 9; PWT L-434.*

P. strobus L., White Pine (M, S, N). (C) Coastal forests, cedar swamps, oak-aspen woods, and some northern hardwoods. *1611, 1908, 3502, 3928; Engelmann; WRO 788, 959; PWT L-539; Wislizenus 998.*

Tsuga canadensis (L.) Carrière, Hemlock (M, S, N). (C) Northern hardwoods. *1618, 1890, 4747; Wislizenus 999.*

TAXACEAE (Yew Family)

Taxus canadensis Marshall, Yew (M, S, N). Local on mainland in northern hardwoods behind dune front; most abundant near the end of Empire Bluffs trail. Common on South Manitou, but apparently absent from North Manitou due to overgrazing by deer. *1723, 4405; Cowles.*

MONOCOTYLEDONS

ALISMATACEAE (Water-plantain Family)

Alisma plantago-aquatica L., Water-plantain (M). (L) Port Oneida bog. *4423.*

Sagittaria latifolia Willd., Duck-potato (M). (F) Edges of lakes and streams. *2649, 4346, 4585; PWT L-1120.*

AMARYLLIDACEAE (Amaryllis Family)

Narcissus poeticus L., Narcissus (M). Locally persisting throughout the National Lakeshore, but spreading slightly at old homesites and along roadsides. *2094.*

N. psuedo-narcissus L., Daffodil (M). (L) Sometimes spreading from cultivation. Even found along M-109 in road-cut south of Glen Haven. *2068.*

ARACEAE (Arum Family)

Arisaema triphyllum (L.) Schott, Jack-in-the-pulpit (M, S, N). (F) Cedar swamps and northern hardwoods. Common on South Manitou; occasional on North Manitou. *1325, 1379, 2163, 2211; WRO 310; EGV 9900.*

COMMELINACEAE (Spiderwort Family)

Tradescantia ohioensis Raf., (M). Locally spreading behind Cleveland Township Cemetery. *2438; PWT L-1702.*

T. virginiana L., (M). (L) Sometimes spreading along roads. *2594.*

CYPERACEAE (Sedge Family)

Carex aquatilis Wahlenb., (M, N). (O) Swales and edges of lakes and streams. *1394, 1959, 3950, 4058, 4073, 4224; PWT L-3367.*

C. arctata Boott, (M, S, N). (O) Coastal forests. *1289, 1388, 2134, 2157a, 4300; WRO 2528.*

C. atherodes Sprengel, (M, S, N). (O) Marshes, black ash swamps, and bog edges. *4104, 4109, 4161, 4383; PWT L-3067.*

C. aurea Nutt., (M, S). (O) Swales, dunes, and moist sandy sites. *2347, 4082, 4273, 4279, 4307.*

C. bebbii (L. Bailey) Fern., (M, S, N). (F) Swales, bogs, and wet open sites. *1828, 2721, 4089, 4242, 4304; PWT L-3435.*

C. blanda Dewey, (M). (L) Northern hardwoods at corner of M-22 and Fowler Rd. *WRO 2526, 2533.*

C. brunescens (Pers.) Poiret, (M, N). (O) Bogs and wet open sites. *1416a, 3166; PWT L-3300.*

C. buxbaumii Wahlenb., (M). (O) Swales and sedge mats. *3429, 3935, 4096; WRO 752; PWT L-3433.*

C. canescens L., (M, N). (O) Bogs, and shore of Crystal River. *1416b, 2229, 2706, 4248; PWT L-3606.*

C. castanea Wahlenb., (M). (F) Wet open sites and cedar swamps. *2275, 3242; WRO 1655.*

C. communis L. Bailey, (M, S). (C) Northern hardwoods, coastal forests, and cedar swamps. *1242, 1352, 2115, 2135, 2153; WRO 2414, 2527, 2529; PWT L-3531.*

C. comosa Boott, (M, S). (O) Swales and lake edges. *3437, 4196, 4250, 4322, 4324; WRO 1484, 1485.*

C. concinna R. Br., (M). (R) Cedar woods near Sleeping Bear Point. *Reznicek 7350.* Michigan special concern species.

C. crawei Dewey, (M). (L) Open pool at Marl Springs. *4448.*

C. crawfordii Fern., (M). (L) Port Oneida bog. *PWT L-3602.*

C. crinita Lam., (M, S, N). (O) Wetlands. *1349, 1399, 3417, 4085; Wislizenus 1018.*

C. cristatella Britton, (M). (L) Black ash swamp near North Bar Lake. *4237.*

C. cumulata (L. Bailey) Fern., (M). (L) Port Oneida bog. *2822; PWT L-3717.*

C. deweyana Schwein., (M, S, N). (O) Northern hardwoods. *1240, 1265, 1389, 2007, 4308; WRO 2530.*

C. diandra Schrank, (M, N). (L) Sedge mats at Tamarack Lake and Otter Creek. *4070, 4126.*

C. disperma Dewey, (M, N). (C) Black ash swamps and cedar swamps. *1988, 2265, 2482, 3239.*

C. eburnea Boott, (M, S, N). (C) Cedar swamps, jack pine stands, dunes, and some fields. *1230, 1312, 1480, 2062, 2143, 4337, 4410; WRO 1414, 1415; EGV 9877.*

C. flava L., (M). (C) Swales and cedar swamps. *2236, 2346, 2486, 3243, 3921.*

C. garberi Fern., (M, S, N). (O) Jack pine stands, dunes, and shores. *1374, 1434, 1747, 1786, 2218, 3059, 4147; WRO 957.*
C. gracillima Schwein., (M). (L) Black ash swamp north of Glen Lake beach. *3418.*
C. granularis Willd., (M). (L) Shore of Round Lake. *WRO 2413.*
C. hichcockiana Dewey, (S). (L) Northern hardwoods near Hutzler Cemetery. *1287.*
C. hystericina Willd., (M, N). (C) Swales, cedar swamps, and black ash swamps. *1369, 2206, 2392, 4072, 4236; WRO 1514; PWT L-3293; Wislizenus 1017.*
C. interior L. Bailey, (M, N). (C) Swales, bogs, and sedge mats. *2205, 2237, 2376b, 2397, 3955, 4128, 4195; PWT L-3016.*
C. intumescens Rudge, (M, S, N). (O) Moist woods. *1350, 3269, 3419, 4540.*
C. lacustris Willd., (M, S, N). (O) Marshes and black ash swamps. *1959, 3413, 4091, 4102, 4130, 4293.*
C. laevivaginata (Kuk.) Mackenzie, (M). (L) Marl Springs. *3246.*
C. lanuginosa Michaux, (M, S). (O) Old fields and some dunes. *1259, 1333, 2696, 3460, 4106.*
C. lasiocarpa Ehrh., (M, S). (O) Sedge meadows, and south end of Lake Florence. *2398, 4193, 4294.*
C. laxiflora Lam., (M). (L) Dry northern hardwoods near Cleveland Township Cemetery. *2157b.*
C. leptalea Wahlenb., (M). (O) Cedar swamps. *2490; WRO 1755, 1896.*
C. leptonervia Fern., (M, S). (O) Moist northern hardwoods. *2158, 2185; PWT L-3622; EGV 9893.*
C. limosa L., (M, N). (O) Bogs and sedge mats. *2715, 3952, 4131, 4194.*
C. lupulina Willd., (M). (L) Black ash swamp north of Glen Lake beach. *3414.*
C. muhlenbergii Willd., (M, S). (F) Dunes and old fields. *1336, 1426, 2245, 2360, 2697; WRO 2426, 2505; PWT L-3633.*
C. oligosperma Michaux, (M). (O) Bogs. *2228, 4424; PWT L-3609, L-3726.*
C. pallescens L. (M). (L) Marl Springs. *3240.*
C. pauciflora Light., (M). (L) M-22 Bog. *PWT L-3432.*
C. pedunculata Willd. (M, S). (L) Oak woods near north side of South Manitou; northern hardwoods at corner of M-22 and Fowler Rd. *1943; WRO 2524.*
C. pensylvanica Lam., (M). (C) Fields, oak-pine woods, and coastal forests. *2286, 3031, 3436; WRO 556, 918, 1407, 2159; PWT L-3325.*
C. plantaginea Lam., (M, S, N). (F) Northern hardwoods. *1502, 1954, 2026, 2076, 2295, 2327, 4121; EGV 9885a.*
C. platyphylla Carey, (M). (L) Dry northern hardwoods, Alligator Hill. *Reznicek 8182.*
C. projecta Mackenzie, (M, S, N). (O) Black ash swamps, marshes, and lake edges. *1398, 3415, 4083, 4315; WRO 2305; EGV 5124.*
C. pseudocyperus L., (M, N). (O) Bogs and cedar swamps. *2708, 2864, 4129; PWT L-3496.*
C. retrorsa Schwein., (M, S, N). (O) Marshes and black ash swamps. *1400, 1892, 3571, 4086, 4159, 4301, 4314.*
C. rosea Willd., (S, M, N). (O) Cedar swamps, black ash swamps, and northern hardwoods. *1324, 1384, 1478, 2152, 3241, 3416; EGV 5129.*
C. rostrata Stokes, (M). (L) Sedge mat along stream at Good Harbor. *PWT L-3366a.*
C. rugosperma Mackenzie, (M). (O) Old fields and coastal forests. *3041; PWT L-3418.*
C. scabrata Schwein., (M, N). (O) Northern hardwoods. *1386, 4786; EGV 5118.*
C. scoparia Willd., (M). (L) Port Oneida bog. *3573, 4260; PWT L-3605.*
C. sparganioides Willd., (N). (L) Woods near fish shanty, North Manitou. *4165.*
C. stipata Willd., (M, S, N). (F) Swales, marshes, and bogs. *1332, 1674, 2204, 2366, 3435, 4092, 4312, 4480; PWT L-3145.*
C. stricta Lam., (M, S). (L) Marl Springs, and marsh west of schoolhouse on South Manitou. *2002, 3248, 4100; WRO 2427.*
C. substricta Lam., (M). (L) Round [Loon?] Lake. *Funk.*
C. tribuloides Wahlenb., (M). (L) Port Oneida bog. *PWT L-3607.*
C. trisperma Dewey, (M, N). (F) Bogs and wet woods. *1421, 2225, 3539, 4373; PWT L-3300, L-3485.*

C. tuckermanii Dewey, (S, N). (L) Woods south of Lake Florence; North Manitou. *1356; Wislizenus 1016.*

C. viridula Michaux, (M, S, N). (C) Jack pine stands, dune pools, and swales. *1330, 1375, 1435, 2219, 3228, 4077, 4274; WRO 1194; PWT L-3061, L-3263.*

C. vulpinoidea Michaux, (M, N). (O) Cedar swamps and marshes. *1401, 2856, 4243; WRO 2306; PWT L-3214, L-3228.*

Cladium mariscoides (Muhlenb.) Torrey, Twig-rush (M, S). (O) Swales and shores. *1751, 2610, 2637, 4367; WRO 1245, 1482; PWT L-3203.*

Cyperus esculentus L., (M). (L) Disturbed field along M-22 south of Welch Rd. *4357.*

C. filiculmis Vahl, (M). (O) Old fields. *2738.*

C. houghtonii Torrey, (M). (L) Roadside, Lake Michigan Rd. (Benzie Co.). *WRO 1047.*

C. rivularis Kunth, (M). (L) Shores of Bass Lake (Benzie Co.) and Shell Lake. *4667a; PWT L-3454.*

C. schweinitzii Torrey, (M, N). (O) Dunes and sandy old fields. *2582, 3682, 4557; EGV 1018.*

Dulichium arundinaceum (L.) Britton, Three-way sedge (M, S, N). (O) Lake edges and swales. *2712, 4291, 4488; WRO 1255.*

Eleocharis elliptica Kunth, (M, S). (C) Swales, dune pools, and lake edges. *1331, 2069, 4266, 4272, 4362; WRO 916, 1220, 1413, 2154.*

E. erythropoda Steudel, (M). (F) Sedge mats, dune pools, and lake edges. *3494, 4080, 4192, 4442; WRO 2282; PWT L-3284.*

E. pauciflora (Light.) Link, (M). (O) Dunes pools. *4277; PWT L-3364.*

E. rostellata Torrey, (M). (L) Sedge mat, Otter Creek. *4436; WRO 1522, 1656.*

E. smallii Britton, (M, S). (O) Swales and lake edges. *1319, 4191, 4221, 4292, 4419.*

Eriophorum spissum Fern., (M, N). (O) Bogs. *2226b, 2720, 3941, 4124; PWT L-3018.*

E. virginicum L., (M, N). (O) Bogs. *2722, 4372, 4391; WRO 1259; PWT L-3486.*

E. viridi-carinatum (Engelm.) Fern., (M). (O) Sedge mats. *2395, 2487, 3953.*

Rhynchospora alba (L.) Vahl, (M). (R) Small bog, Otter Creek. *WRO 1660.*

R. capillacea (Michaux) Torrey, (M). (R) Shore of Bass Lake (Benzie Co.). *WRO 1521.*

Scirpus acutus Bigelow, Hardstem Bulrush (M, S, N). (C) Shores and lake edges. *1468, 1506, 3954, 4507, 4787; WRO 949.*

S. americanus Pers., (M). (O) Lake edges. *2656, 4084.*

S. atrovirens Willd., (M, N). (C) Swales and lake edges. *1417, 2511, 2573, 3411, 4543; PWT L-3155.*

S. cyperinus (L.) Kunth, (M, S, N). (F) Black ash swamps, marshes, and bogs. *2719, 2816, 3572, 4385, 4401, 4484, 4544; PWT L-3248, L-3335; EGV 5120.*

S. microcarpus C. Presl, (N). (L) Gravel shore of Lake Michigan near fish shanty, North Manitou. *1614.*

S. validus Vahl, (M, N). (L) Tamarack Lake, and swales near Shalda Creek. *2707, 4684.*

GRAMINEAE [POACEAE] (Grass Family)

Agropyron dasystachyum (Hook.) Scribner, (M, S, N). (F) Dunes and shores. *1304, 1403, 2242, 2452b; Engelmann; WRO 177, 958; EGV 5141; Wislizenus 1021.*

A. repens (L.) Beauv., Quackgrass (M, S, N). (C) Old fields and roadsides. *1247, 1460, 2296, 2584, 2678, 3397, 3450, 3451, 3587; PWT L-3095.*

A. trachycaulum (Link) Malte, (M). (L) Coastal forest west of Otter Creek. *WRO 2265.*

Agrostis gigantea Roth, Redtop (M, S, N). (C) Swales, marshes, and shores. *1568, 1612, 2506, 3567, 3659b, 4284, 4323, 4447, 4485, 4503, 4544a; WRO 1061, 1064; PWT L-3030, L-3230, L-3494.*

A. hyemalis (Walter) BSP., (M, S). (O) Swales. *1750; WRO 1510.*

Ammophila breviligulata Fern., Beach Grass (M, S, N). (C) Dunes and shores. *1557, 1658, 2627, 3497; Engelmann; WRO 102; PWT L-3022; EGV 1020, 5139.*

Andropogon gerardii Vitman, Big Bluestem (M). (O) Dunes and roadsides especially in Platte River unit. *2828, 2936, 3488; WRO 1246, 2622, 2624, 2625; PWT L-3321.*

A. scoparius Michaux, Little Bluestem (M, S, N). (C) Dunes. *1715, 2834, 3496, 4575; WRO 259; PWT L-3094, L-3301; EGV 1021.*

Arrhenatherum elatius (L.) Presl, Tall Oatgrass (M). (L) Roadsides. *2592, 2615.*

Avena sativa L., Oats (M). (L) Roadside, Day Forest Rd. *2661.*

Bromus ciliatus L., Fringed Brome (M). (L) Shore of Bass Lake (Benzie Co.). *WRO 1519.*

B. inermis Leysser, Smooth Brome (M, S, N). (C) Old fields and roadsides. *1355, 1452, 2316, 2444.*

B. pumpellianus Scribner, Pumpelly's Brome Grass (M, S, N). (O) Perched dunes, especially on Manitou Islands. *1659, 1737, 3396.* Michigan threatened species.

B. racemosus L., (M). (L) Along Lake Michigan Rd. (Benzie Co.). *WRO 2856.*

B. tectorum L., Downy Chess (M, S). (O) Sandy old fields. *1741, 2400, 2607; WRO 413, 2858.*

Calamagrostis canadensis (Michaux) Beauv., Blue-joint (M, S, N). (C) Black ash swamps, swales, and edges of lakes and streams. *1576, 1678, 3410, 3440, 4208, 4359, 4463; WRO 1198, 1926, 2315.*

C. inexpansa A. Gray, (M). (O) Edges of lakes and streams. *4363, 4666, 4678.*

Calamovilfa longifolia (Hook.) Scribner, (M, S, N). (C) Dunes and shores. *1555, 1713, 2626, 2764, 4564; WRO 1058.*

Cinna latifolia (Goeppert) Griseb., (M, N). (O) Edges of lakes and streams. *2640, 2700, 2703, 4395; EGV 5122.*

Dactylis glomerata L., Orchard Grass (M, S, N). (C) Old fields and roadsides. *1250, 1454, 2334, 3427.*

Danthonia spicata (L.) Roemer & Schultes, Oatgrass (M, S, N). (C) Old fields. *1467, 1533, 2695, 2730, 3517, 4261; PWT L-3057, L-3482.*

Deschampsia flexuosa (L.) Beauv., (M). (F) Dry coastal forests. *4271, 4472; WRO 13, 116, 426, 950; PWT L-3323.*

Digitaria sanguinalis (L.) Scop., (M). (F) Disturbed ground and roadsides. *2665, 4356, 4826.*

Echinochloa crusgalli (L.) Beauv., Barnyard Grass (M). (O) Disturbed ground and roadsides. *2621, 3876; WRO 1052.*

E. muricata (Beauv.) Fern., (M, N). (L) Along Crystal River; North Manitou. *4816; Cowles.*

Elymus arenarius L., (M). (R) Shore of Lake Michigan west of Platte River mouth. *3455.*

E. canadensis L., (M, S, N). (F) Dunes and shores. *1588, 1734, 2559, 2662; WRO 1048, 1049; EGV 5140.*

Eragrostis cilianensis (All.) Mosher, Stink Grass (M). (F) Disturbed ground. *2605, 2963, 4355; PWT L-3357.*

E. spectabilis (Pursh) Steudel, Tumble Grass (M). (O) Disturbed ground. *2739.*

E. trichoides (Nutt.) A. Wood, (M). (L) Along Lake Michigan Rd. (Benzie Co.). *WRO 2358.*

Festuca gigantea (L.) Villars (M). (L) Marl Springs. *3624.*

F. obtusa Biehler, Nodding Fescue (S, N). (O) Northern hardwoods. *2680, 2728; EGV 5115.*

F. occidentalis Hook., (M, S). (O) Trail near Gull Point, South Manitou; coastal forest along Lake Michigan Rd. (Benzie Co.). *1296; WRO 2855.*

F. ovina L., Sheep Fescue (M, S). (O) Old fields and roadsides. *1249, 1334, 2569.*

F. pratensis Hudson, (N). (L) Wet swale near the West Side, North Manitou. *4145.*

F. rubra L., (S, N). (O) Old fields. *1442a, 1457, 4098, 4320, 4552.*

F. saximontana Rydb., (M, S). (O) Dunes. *1553, 2377.*

Glyceria borealis (Nash) Batch., (S). (L) South end of Lake Florence. *1503.*

G. canadensis (Michaux) Trin., Rattlesnake Manna Grass (M). (L) Edge of Bow Lakes bog. *4384.*

G. striata (Lam.) A. Hitchc., Fowl Manna Grass (M, S, N). (C) Marshes, cedar swamps, black ash swamps, and swales. *2518, 2859, 3420, 4074, 4233, 4302; WRO 1927, 1928, 2589; EGV 5127.*

Hierochloë odorata (L.) Beauv., Sweet Grass (M). (L) Wet field near Day Forest Rd. *3049.*

Hystrix patula Moench, Bottlebrush Grass (M, N). (O) Northern hardwoods. *1624, 2406, 2533.*

Koeleria macrantha (Ledeb.) Schultes, June Grass (M, S, N). (F) Dunes. *1436, 1714, 2609, 2625, 3491, 4565; WRO 427; PWT L-3028, L-3202, L-3232; EGV 1019.*

Leersia oryzoides (L.) Sw., Cut Grass (M). (O) Swales and black ash swamps. *4481, 4839.*

Leptoloma cognatum (Shultes) Chase, (M). (L) Old field along Pyramid Point trail. *3637.*

Melica smithii (A. Gray) Vasey, (M, S, N). (C) Northern hardwoods. *1479, 1572, 1615, 2182, 2322, 2354, 2408, 2477; WRO 1188, 1189, 2155, 2156; EGV 5116.*

Milium effusum L., (M, S, N). (F) Northern hardwoods. *1323, 1423, 1861, 2298, 2330, 2699; EGV 5114, 9902.*

Muhlenbergia glomerata (Willd.) Trin. (M). (L) Sedge mat, Round Lake. *WRO 1481.*

Oryzopsis asperifolia Michaux, (M, S, N). (F) Northern hardwoods and coastal forests. *1297, 1470, 2059, 2238; WRO 597, 919, 1931.*

O. pungens (Sprengel) A. Hitchc., (M). (L) Coastal forest along Good Harbor Bay. *2426a.*

O. racemosa (Smith) A. Hitchc., (M, N). (O) Coastal forests. *1840, 2538, 3520, 3880; WRO 2532.*

Panicum capillare L., (M). (O) Old fields and roadsides. *2596, 2668, 3873; WRO 1063.*

P. commonsianum Ashe, (M). (L) Coastal forests. *2503; WRO 1197; PWT L-3231.*

P. depauperatum Muhlenb. (M). (L) Coastal forest north of Platte River Campground. *WRO 2504.*

P. flexile (Gattinger) Scribner, (M). (L) Cedar swamp near Otter Lake. *WRO 2285.*

P. implicatum Britton, (M, S, N). (O) Dune pools, sandy fields, and lake edges. *1371, 1660, 4276, 4671; WRO 1937, 2792, 3489.*

P. latifolium L., (M). (L) Roadside, Deadstream Rd. near M-22. *WRO 2781.*

P. linearifolium var. *werneri* (Britton) Fern., (N). (L) Carlson Place clearing, North Manitou. *1701.*

P. praecocius A. Hitchc. & Chase, (M). (L) Bow Lakes sedge mat. *2390.*

P. virgatum L., Switch Grass (M). (F) Dunes, fields, and lake edges. *2604, 2631, 2762, 4464; WRO 1059, 1060, 2470; PWT L-3053.*

P. xanthophysum A. Gray, (M). (L) Coastal forest along Good Harbor Bay. *PWT L-3057.*

Phalaris arundinacea L., Reed Canary Grass (M). (O) Lake edges and roadsides. *2528, 2562, 2653, 4076; PWT L-3338.*

Phleum pratense L., Timothy (M, S, N). (C) Old fields and roadsides. *1396, 1542, 2409, 2442; WRO 1929.*

Phragmites australis (Cav.) Steudel, Reed (M, S, N). (O) Lake and stream edges. *1887, 2704; PWT L-3075, L-3532.*

Poa alsodes A. Gray, (M, S, N). (O) Northern hardwoods. *1387, 2011, 2184, 2326, 2407; WRO 2854; EGV 9887a.*

P. compressa L., Canada Bluegrass (M, S, N). (C) Old fields and roadsides. *1532, 1601, 3229, 3641, 4321; WRO 98, 1062, 1195, 1201, 1252, 1925, 1935, 1945, 2416, 2706; PWT L-3050, L-3295.*

P. nemoralis L., (N). (L) Northern hardwoods near Pot Holes, North Manitou. *1477.*

P. palustris L., Fowl Meadow Grass (M, N). (O) Lake edges. *1641, 1780, 4343a.*

P. pratensis L., (M, S, N). (F) Old fields and roadsides. *1246, 1453, 1455, 1552, 2317, 2441, 3222.*

P. saltuensis Fern. & Wieg., (M). (L) Northern hardwoods near Aral. *WRO 2578.*

Schizachne purpurascens (Torrey) Swallen, False Melic (M, S). (O) Northern hardwoods and some moist coastal forests. *1940, 3165; EGV 9894.*

Secale cereale L., Rye (M). (O) Roadsides. *2292, 2293; WRO 1581, 1906.*

Setaria viridis (L.) Beauv., Green Foxtail (M, S). (F) Disturbed ground and roadsides. *2619, 2666, 3469, 4501; WRO 1053, 1690.*

Spartina pectinata Link, Cordgrass (M). (L) Shore of Platte River. *4783; WRO 1050.*

Sphenopholis intermedia (Rydb.) Rydb., (M, N). (O) Lake shores. *4399, 4508; PWT L-3296.*

Sporobolus cryptandrus (Torrey) A. Gray, (M). (L) Along Trail's End Rd. *2593.*

S. vaginiflorus (Torrey) A. Wood, (M). (L) Roadside near Pyramid Point. *PWT L-3506.*

HYDROCHARITACEAE (Frog's-bit Family)

Elodea canadensis Michaux, Elodea (M). (C) Lakes and streams. *4044, 4229, 4473, 4580; PWT L-872.*

Vallisneria americana Michaux, Tape-grass (M). (F) Lakes and streams. *4456, 4582; WRO 1044.*

IRIDACEAE (Iris Family)

Iris pseudacorus L., Yellow Flag (M). (L) Shore of Platte River near M-22; old farm pond near Shell Lake. *4064, 4173; WRO 1586.*

I. versicolor L., Wild Blue Flag (S, N). (L) South end of Lake Florence; marshy West Side, North Manitou, where blue and white flower color forms grow together. *1320, 1492, 1493.*

I. virginica L., Southern Blue Flag (M, S, N). (F) Swales, edges of lakes and streams. *1414, 2289, 2340, 2367; WRO 17, 1583, 1822, 2313.*

Sisyrinchium angustifolium Miller, (M). (R) Otter Creek. *WRO 1000.*

S. montanum E. Greene, Blue-eyed-grass (M, N). (L) Old field at end of Greenan Rd; some old fields on North Manitou. *3960, 4139, 4758.*

JUNCACEAE (Rush Family)

Juncus acuminatus Michaux (M). (L) Swale near Peterson Rd. *WRO 1256.*

J. alpinus Villars, (M, S, N). (L) Dune pools, shores, lake edges, and swales. *1603, 4275, 4325, 4672a; WRO 1446; PWT L-3262; EGV 2863.*

J. balticus Willd., (M, S, N). (F) Dune pools, shores, lake edges, and swales. *1316, 1456, 1827, 4095; WRO 690, 1193, 1936; PWT L-3097, L-3159.*

J. brachycephalus (Engelm.) Buchenau, (M). (O) Lake edges. *4467.*

J. brevicaudatus (Engelm.) Fern., (M). (L) Shore near Glen Lake beach. *4389, EGV 2864.*

J. canadensis La Harpe, (M). (O) Swales and lake edges. *4416, 4687; PWT L-3265; EGV 2866.*

J. dudleyi Wieg., (M). (O) Swales and shores. *2542; PWT L-3157, L-3229, L-3495.*

J. effusus L., (M, N). (O) Dune pools and wet woods. *2512, 4125, 4259.*

J. nodosus L., (M). (O) Swales and shores. *4446, 4468; WRO 1445; PWT L-3264, L-3364.*

J. pelocarpus E. Meyer, (S). (L) Shores of Lake Florence. *1743.*

J. tenuis Willd., (M, S, N). (O) Trails and two-tracks. *1687, 1699, 1709, 1834, 3412.*

J. torreyi Cov., (M). (L) Wet field near Walsh Rd. *4833.*

Luzula multiflora (Retz.) Lej., (M). (L) Two-track east of Bass Lake (Benzie Co.). *2264.*

JUNCAGINACEAE (Arrow-grass Family)

Scheuchzeria palustris L., Bog Arrow-grass (M). (L) Bogs near M-22 and at Bow Lakes area. *2900; PWT L-2109.*

Triglochin palustre L., (M). (O) Dune pools and shores. *4278, 4406, 4670, 4814; PWT L-1201.*

LEMNACEAE (Duckweed Family)

Lemna minor L., Duckweed (M, N). (C) Lakes and streams. *1490, 4427; PWT L-1782.*

L. trisulca L., Star Duckweed (M). (L) Mill Pond and Shell Lake. *4227; PWT L-571, L-1781.*

Spirodela polyrhiza (L.) Schleiden, Greater Duckweed (M). (L) Day Mill Pond; swales near Hidden Lake. *4412, 4845; PWT L-1334.*

Wolffia columbiana Karsten, Water-meal (M, N). (L) Edges of Narada Lake; along outlet of Lake Manitou near Pole Bridge. *4547a, 4719.*

LILIACEAE (Lily Family)

Allium cernuum Roth. (N). (L) Northern Hardwoods. *EGV 5145.*

A. tricoccum Aiton, Wild Leeks (M, S, N). (C) Northern hardwoods. *1511, 1600, 2526b, 2549, 4286; WRO 39, 569; PWT L-287; EGV 5117, 9892.*

Asparagus officinalis L., Garden Asparagus (M, S, N). (O) Old fields and roadsides. *1536, 1635, 2532, 2796.*

Clintonia borealis (Aiton) Raf., Corn-lily (M, S, N). (F) Northern hardwoods. *1761, 2630, 2786; Engelmann; PWT L-861; Wislizenus.*

Convallaria majalis L., Lily-of-the-valley (M, S, N). (L) Spreading from cultivation at cemeteries and former homesites. *1218, 1408, 2148, 2200.*

Erythronium americanum Ker Gawler, Adder's-tongue (M, S, N). (C) Northern hardwoods. *1931, 2032, 2049.*

Hemerocallis fulva (L.) L., Orange Day-lily (M). (O) Roadsides. *2773, 4268, 4755.*

H. lilio-asphodelus L., Yellow Day-lily (M). (L) Roadsides. *2339, 2405; WRO 1403.*

Lilium philadelphicum L., Wood Lily (M, S, N). (C) Dunes. *1344, 2415, 2453, 4148.*

Maianthemum canadense Desf., Canada Mayflower (M, S, N). (C) Northern hardwoods and cedar swamps. *1232, 1474, 2186, 2244; PWT L-64, L-1864, L-2180; Wislizenus 1009.*

Medeola virginiana L., Indian Cucumber-root (M, S). (L) Northern hardwoods along Dune Valley Rd., and west of schoolhouse, South Manitou. *1814, 2466, 3159; PWT L-138.*

Polygonatum pubescens (Willd.) Pursh, Hairy Solomon's Seal (M, S, N). (F) Northern hardwoods. *1238, 2249, 2333, 4164; WRO 253; PWT L-1867; EGV 9886a.*

Smilacina racemosa (L.) Desf., False Spikenard (M, S). (F) Northern hardwoods. *1290, 1731, 2743, 2790; WRO 252.*

S. stellata (L.) Desf., Starry False Solomon's Seal (M, S, N). (C) Dunes. *1266, 1299, 2128, 2424, 4203; WRO 104, 579; PWT L-63, L-794; EGV 9901.*

S. trifolia (L.) Desf., Three-leaved False Solomon's Seal (M). (L) Cedar swamp at Otter Creek; M-22 bog. *2172, 3170.*

Streptopus roseus Michaux, Rose Mandarin (M, S, N). (O) Northern hardwoods. *1763, 3947, 4166, 4762; PWT L-1863; EGV 9890.*

Trillium cernuum L., Nodding Trillium (M). (L) Northern hardwoods near Hidden Lake. *3945.*

T. erectum L., Stinking Benjamin (S). (L) Northern hardwoods and at Cedars, South Manitou. *1936, 1938; PWT L-1854, L-1907, L-1936; EGV 9888.*

T. flexipes Raf., Drooping Trillium (S). (L) Cedars, South Manitou. *3055, 3911; PWT L-1898, L-1901, L-1932; EGV 9905.*

T. erectum L. × *T. flexipes* Raf., (S). (L) Cedars, South Manitou. *3912, 3913; PWT L-1856, L-1902, L-1937.*

T. grandiflorum (Michaux) Salisb., Common Trillium (M, S, N). (C) Northern hardwoods. *1933, 1978, 2033, 2054, 4736; WRO 302, 565; PWT L-1857; EGV 3859, 9985, 9986.*

Uvularia grandiflora Smith, Bellwort (M, S, N). (O) Northern hardwoods. *1932, 2248, 3042; Cowles.*

Zigadenus glaucus (Nutt.) Nutt., White Camas (M, S, N). (F) Dunes. *1551, 1657, 2496, 3548; WRO 260; PWT L-280.*

NAJADACEAE (Naiad Family)

Najas flexilis (Willd.) Rostk. & Schmidt, Naiad (M). (C) Lakes and streams. *4217, 4255, 4522, 4581; PWT L-576; WRO 1491.*

ORCHIDACEAE (Orchid Family)

Aplectrum hyemale (Willd.) Torrey, Putty-root (M). (O) Northern hardwoods. *3138, 3944; PWT L-1256.*

Calopogon tuberosus (L.) BSP., Grass-pink (N). (L) North Manitou. *Wislizenus 615.*

Calypso bulbosa (L.) Oakes, Calypso (S). (L) Coastal forest along edge of dunes bordering bay, South Manitou. *2000.* Michigan threatened species.

Corallorhiza maculata Raf., Spotted Coral-root (M, S, N). (F) Jack pine stands, coastal

forests, and northern hardwoods. *1623, 1705, 2839, 3495, 4059, 4282; Engelmann; PWT L-213, L-1567; EGV 5128.*

C. odontorhiza (Willd.) Nutt., Autumn Coral-root (M). (O) Old fields and woods edges. *4730, 4732.*

C. striata Lindley, Striped Coral-root (M, S, N). (F) Coastal forests and jack pine stands. *1268, 1393, 2220, 3926; WRO 573; Wislizenus 617.*

C. trifida Chatel., Early Coral-root (M, S). (O) Cedar swamps. *1951, 2523, 3169, 3925; PWT L-862.*

Cypripedium acaule Aiton, Stemless Lady-slipper (M, S). (F) Coastal forests of Platte River unit, jack pine stands, and bogs. Rare on South Manitou. *2280, 3940; PWT L-1510.*

C. arietinum R. Br., Ram's-head Lady-slipper (M, S). (L) Jack pine stands; coastal forests of Good Harbor Bay and South Manitou. *2222, 3473; WRO 263, 299, 301, 1866; PWT L-1633.* Michigan special concern species.

C. calceolus L., Yellow Lady-slipper (M, S). (L) Wet areas around Otter Lake; upland sites in northern hardwoods bordering dunes at Sleeping Bear Plateau and Pyramid Point; Cedars, South Manitou. *2004, 2258, 2273; PWT L-1862, L-1866, L-1943; EGV 9883.*

C. reginae Walter, Showy Lady-slipper (M). (L) Cedar swamps near Otter Creek, shore of Hidden Lake, and wet woods east of Little Traverse Lake. *2423.*

Epipactis helleborine (L.) Crantz, Helleborine (M, S, N). (F) Northern hardwoods. *1537, 1652, 1760, 2674, 3521.*

Goodyera oblongifolia Raf., Giant Rattlesnake-plantain (M, S, N). (F) Young woods and coastal forests. *1704, 1822, 3528, 3601, 4498; WRO 2707.*

G. repens (L.) R. Br., Dwarf Rattlesnake-plantain (M, S, N). (L) Coastal forests and northern conifers, South Manitou; Pot Holes, North Manitou; Otter Creek cedar swamp. *1729, 1787, 4496; WRO 626; Wislizenus 609.*

G. tesselata Lodd., Checkered Rattlesnake-plantain (S). (L) Coastal forest east of schoolhouse, South Manitou. *1807; PWT L-1951.*

Habenaria blephariglottis (Willd.) Hook. [*Platanthera blephariglottis* (Willd.) Lindley], White-fringed Orchid (M). (L) M-22 bog. *PWT L-1677.*

H. clavellata (Michaux) Sprengel [*Platanthera clavellata* (Michaux) Luer], Club-spur Orchid (M, N). (O) Cedar swamps. *3608; Wislizenus.*

H. dilatata (Pursh) Hook. [*Platanthera dilatata* (Pursh) Lindley ex Beck], Bog Candle (M). (L) Fen-like area in cedar swamp along Otter Creek. *2522; WRO 524.*

H. hookeri A. Gray [*Platanthera hookeri* (Torr.) Lindley], Hooker's Orchid (M). (L) Moist coastal forest near Shalda Creek; moist hardwoods east of Platte River Campground. *4781; WRO 31.*

H. hyperborea (L.) R. Br. [*Platanthera hyperborea* (L.) Lindley], Tall Northern Bog Orchid (M, N). (F) Cedar swamps. *1689, 2481, 2629, 3611, 4396; Wislizenus 606.*

H. lacera (Michaux) Lodd. [*Platanthera lacera* (Michaux) G. Don], Green-fringed Orchid (M, N). (L) Alder thicket west of Narada Lake; North Manitou. *4428; Wislizenus 608.*

H. obtusata (Pursh) Richardson [*Platanthera obtusata* (Banks ex Pursh) Lindley], Blunt-leaf Orchid (M). (L) Cedar swamps at Otter Creek and Crystal River. *2524, 2544; WRO 1238.*

H. orbiculata (Pursh) Torrey [*Platanthera orbiculata* (Pursh) Lindley], Round-leaved Orchid (M, S, N). (F) Northern hardwoods. *1365, 2329, 3472; PWT L-216; Wislizenus 607.*

H. psycodes (L.) Sprengel [*Platanthera psycodes* (L.) Lindley], Purple-fringed Orchid (M, S). (O) Black ash swamps; edges of lakes and streams. *1707, 4393; PWT L-2250.*

H. viridis (L.) R. Br. [*Coeloglossum viride* (L.) Hartman], Long-bracted Green Orchid (M, S, N). (F) Northern hardwoods. *1353, 1727, 1992, 2325; PWT L-88, L-961; EGV 3860, 9884.*

Liparis loeselii (L.) Rich., Fen Orchid (M, S). (O) Cedar swamps, sedge mats, and some lake edges. *2880, 3276; PWT L-1118.*

Listera convallarioides (Sw.) Torrey, Broad-leaved Twayblade (M, N). (L) Cedar swamp along Crystal River. *2545; Wislizenus 690.*

Malaxis monophylla (L.) Sw., White Adder's-mouth (M). (R) Jack pines, Aral. *WRO 2640.*

Pogonia ophioglossoides (L.) Ker Gawler, Rose Pogonia (M). (L) Port Oneida bog. *PWT L-2106.*

Spiranthes cernua (L.) Rich. (M). (L) Glen Lake Beach. *4690.*

S. lacera (Raf.) Raf., Slender Ladies'-tresses (M, S). (L) Jack pine stands, oak-pine woods west of Otter Creek, and coastal forest near dunes on South Manitou. *1718, 2884, 3490, 4428; WRO 258; PWT L-435.*

S. romanzoffiana Cham., Hooded Ladies'-tresses (M, S, N). (F) Lake shores. *1913, 2872, 4364, 4407; Wislizenus.*

Triphora trianthophora (Sw.) Rydb., Three Birds Orchid (M). (R) Northern hardwoods, Alligator Hill. *3881.* Michigan threatened species.

PONTEDERIACEAE (Pickerel-weed Family)

Heteranthera dubia (Jacq.) MacMillan, Water Star-grass (M). (F) Lakes and streams. *4477, 4668, 4725.*

POTAMOGETONACEAE (Pondweed Family)

Potamogeton amplifolius Tuckerman, (M, S). (C) Lakes. *4055, 4216, 4254, 4289, 4492, 4709.*

P. berchtoldii Fieber, (M, S). (F) Lakes. *4207, 4252, 4288, 4349, 4491.*

P. crispus L., (M). (O) Lakes and streams. *4230, 4256.*

P. filiformis Pers., (M, N). (L) Lake Manitou, Glen Lake, and Round [Loon?] Lake. *3943, 4517; Funk.*

P. foliosus Raf., (M, N). (C) Lakes. *4457, 4470, 4547, 4574, 4703, 4825, 4832; PWT L-572.*

P. friesii Rupr., (M). (O) Streams. *4475, 4707, 4711, 4830; WRO 1267.*

P. gramineus L., (M, S, N). (C) Lakes and streams. *4045, 4065, 4187, 4222, 4251, 4287, 4493, 4523, 4700; WRO 1495; PWT L-420.*

P. illinoensis Morong, (M, N). (C) Lakes and streams. *4212, 4258, 4583, 4680, 4708, 4824; WRO 1492; PWT L-573, L-1546.*

P. natans L., (M, N). (C) Lakes and streams. *4056, 4519, 4547b.*

P. oakesianus Robb., (M). (L) Bog ponds, Port Oneida area. *4265a, 4418.*

P. pectinatus L., (M, N). (C) Lakes and streams. *4432, 4455, 4589, 4669, 4697; WRO 1267a, 1517.*

P. praelongus Wulfen, (M, N). (L) Narada Lake, Lake Manitou, and Round [Loon?] Lake. *4350, 4525; Funk.*

P. richardsonii (A. Bennett) Rydb., (M, N). (C) Lakes and streams. *4228, 4257, 4368, 4476, 4524, 4579; WRO 1518.*

P. robbinsii Oakes, (M). (L) Otter Lake and Round [Loon?] Lake. *4369; Funk.*

P. strictifolius A. Bennett, (M). (L) Bass Lake (Benzie Co.). *4831.*

P. zosteriformis Fern., (M). (C) Lakes. *4215, 4829.*

SPARGANIACEAE (Bur-reed Family)

Sparganium americanum Nutt. (M). (L) Stream south of school Lake. *4398.*

S. chlorocarpum Rydb., (M, N). (F) Swales; edges of lakes and streams. *4348, 4534, 4588; WRO 2753; PWT L-1343, L-3160.*

S. eurycarpum Engelm., (M, N). (L) Platte River; North Manitou. *4175; Wislizenus 601.*

S. fluctuans (Morong) Robinson, (M). (L) Taylor Lake. *4199.*

S. minimum (Hartman) Fries, (M). (O) Swales. *3453, 4342, 4413.*

TYPHACEAE (Cat-tail Family)

Typha angustifolia L., Narrow-leaved Cat-tail (M, S). (F) Roadside ditches and lake edges. *1578, 3543, 4219; PWT L-1695, L-1804.*

T. latifolia L., Common Cat-tail (M, S, N). (C) Marshes, roadside ditches, and edges of lakes and streams. *2565, 2701, 3426, 4218, 4220, 4295.*

DICOTYLEDONS

ACERACEAE (Maple Family)

Acer negundo L., Box-elder (M). (O) Roadside escape. *2183, 3676, 3683.*

A. pensylvanicum L., Striped Maple (M, S, N). (F) Northern hardwoods. *1693, 2085, 2426b; PWT L-405, L-921, L-1549.*

A. rubrum L., Red Maple (M, S, N). (C) Coastal forests, northern hardwoods, and edges of lakes and streams. *1291, 1639, 2041, 2123, 3175; WRO 576.*

A. saccharum Marshall, Sugar Maple (M, S, N). (C) Northern hardwoods. *1406, 1517, 1924, 2154, 2908.*

A. spicatum Lam., Mountain Maple (M, S, N). (F) Northern hardwoods and swamps. *1346, 1390, 1620, 2165, 2279; Engelmann; EGV 9884A.*

AMARANTHACEAE (Amaranthus Family)

Amaranthus albus L., Tumbleweed (M, N). (O) Disturbed ground. *2601, 2966, 4351, 4806, 4827.*

A. blitoides S. Watson, (M). (L) Roadside south of Empire. *PWT L-1249.*

A. powellii S. Watson, (M). (C) Disturbed ground and roadsides. *2600, 2623, 2918, 2964; WRO 2283; PWT L-1225.*

A. retroflexus L., (M). (O) Disturbed ground. *4352; PWT L-1227.*

ANACARDIACEAE (Cashew Family)

Rhus ×*pulvinata* E. Greene, (M). (L) Along M-22 near Lutheran cemetery. *3524.*

R. typhina L., Staghorn Sumac (M, S). (C) Old fields. *1515, 2558, 2734.*

Toxicodendron radicans (L.) Kuntze, Poison-ivy (M, S, N). (C) Dunes and old field edges. *1902, 4728, 4808; WRO 861; EGV 9878.*

APOCYNACEAE (Dogbane Family)

Apocynum androsaemifolium L., Dogbane (M, S, N). (F) Old fields and roadsides. *2587, 2679, 4794, 4854; Wislizenus 579.*

A. cannabinum L., Indian Hemp (M). (O) Shores and roadside ditches. *2634, 3278, 4691.*

Vinca minor L., Common Periwinkle (M, S). (F) Spreading from former home sites. *1269, 2120, 3154; WRO 555.*

AQUIFOLIACEAE (Holly Family)

Ilex verticillata (L.) A. Gray, Michigan Holly (M, S, N). (F) Swales, marshes, and bog edges. *1810, 3019, 3441; PWT L-404, L-1578.*

Nemopanthus mucronatus (L.) Loes., Mountain-holly (M, N). (O) Bogs. *2854; PWT L-182, L-1577; EGV 5131.*

ARALIACEAE (Ginseng Family)

Aralia hispida Vent., Bristly Sarsaparilla (M, S, N). (L) Old blueberry patch east of Otter Creek; old field about 1/2 mile east of South Manitou village; North Manitou. *1771, 2891; Engelmann; Wislizenus 520.*

A. nudicaulis L., Wild Sarsaparilla (M, S, N). (C) Northern hardwoods, cedar swamps, and coastal forests. *1264, 2142, 2276; WRO 338.*

A. racemosa L., Spikenard (M, S, N). (F) Northern hardwoods. *1735, 3634, 4285; Wislizenus 519.*

Panax quinquefolius L., Ginseng (M, S). (L) Rich northern hardwoods often near dunes. *1897, 4820.* Michigan threatened species.

ASCLEPIADACEAE (Milkweed Family)

Asclepias incarnata L., Swamp Milkweed (M). (O) Lake edges and swales. *2500, 3483; WRO 458.*

A. syriaca L., Common Milkweed (M, S, N). (C) Dunes, old fields, and roadsides. *1564, 1700, 2554, 2642; PWT L-1116; EGV 5158.*

A. tuberosa L., Butterfly Weed (M). (O) Roadsides and some relict dunes. *2451, 2502, 3457, 4267; WRO 109.*

A. verticillata L., Whorled Milkweed (M, S). (L) Along roadside M-109 near Welch Rd.; old field east of schoolhouse, South Manitou. *1889, 2974.*

A. viridiflora Raf., Green Milkweed (M, S). (O) Dunes. *1556, 3498; WRO 684, 1202; PWT L-920, LB-2263.*

BALSAMINACEAE (Touch-me-not Family)

Impatiens capensis Meerb., Spotted Touch-me-not (M, N). (F) Black ash swamps and roadside ditches. *2793, 2983, 3026, 4511.*

BERBERIDACEAE (Barberry Family)

Caulophyllum thalictroides (L.) Michaux, Blue Cohosh (M, S, N). (O) Northern hardwoods. *1486, 1869, 2907, 3466.*

BETULACEAE (Birch Family)

Alnus rugosa (Duroi) Sprengel, Speckled Alder (M). (F) Swales and lake edges, sometimes forming thickets. *2776, 4238a, 4749.*

Betula alleghaniensis Britton, Yellow Birch (M, S, N). (F) Northern hardwoods and black ash swamps. *1912, 2445, 2893, 3586, 4136.*

B. papyrifera Marshall, White Birch (M, S, N). (C) Jack pine stands, coastal forests, northern hardwoods, and cedar swamps. *1485, 1548, 1922, 2058, 3464; Engelmann.*

B. pumila L., Bog Birch (M). (F) Lake edges and swales of Platte River unit. *3448.*

Corylus cornuta Marshall, Beaked Hazelnut (M). (L) South of Empire near county line and M-22. *PWT L-1253.*

Ostrya virginiana (Miller) K. Koch, Ironwood (M, S, N). (C) Northern hardwoods. *1337, 1407, 1684, 2740, 2761.*

BORAGINACEAE (Forget-me-not Family)

Cynoglossum boreale Fern., Northern Wild Comfrey (M). (O) Cedar swamps. *2267, 3168, 4050; WRO 340; PWT L-129, LB-2392.*

C. officinale L., Common Hound's-tongue (M, S, N). (O) Disturbed ground; northern hardwoods of North Manitou. *1385, 1575, 2378.*

Echium vulgare L., Blueweed (M). (O) Old fields and roadsides. *2436, 2783; WRO 1427.*

Hackelia deflexa (Wahlenb.) Opiz, (M, N). (L) Trails through northern hardwoods. *1469, 4052, 4120, 4183.*

H. virginiana (L.) I.M. Johnston, (M). (L) Shaded roadside, Aral. *WRO 1117.*

Lithospermum caroliniense (Walter) MacMillan, Puccoon (M, S, N). (C) Dunes. *1293, 1432, 2217, 2239; Engelmann; WRO 18, 121, 307; PWT LB-2256; EGV 9882; Wislizenus 574.*

L. officinale L., (M). (L) Coastal dunes near Glen Haven. *PWT L-672.*

Myosotis micrantha Pallas, (M). (L) Disturbed areas such as campgrounds. *4744; PWT L-1868.*

M. scorpioides L., True Forget-me-not (M). (F) Edges of lakes and streams. *4177, 4210, 4453, 4578.*

M. sylvatica Hoffm., (M). (O) Moist shady, disturbed sites. *2113, 2121, 3938.*

CAMPANULACEAE (Harebell Family)

Campanula aparinoides Pursh, Marsh Bellflower (M). (F) Swales and wet woods. *2575, 2831, 3519; PWT L-561.*

C. rotundifolia L., Harebell (M, S, N). (C) Dunes and some old fields. *1428, 1584, 2361, 2468; WRO 10; PWT L-97; Wislizenus 558.*

CAPRIFOLIACEAE (Honeysuckle Family)

Diervilla lonicera Miller, Bush Honeysuckle (M, S, N). (O) Northern hardwoods. *1706, 2534, 2915; Engelmann; PWT L-122, L-1556.*

Linnaea borealis L., Twinflower (M, S, N). (F) Coastal forests and cedar swamps. *1361, 1473, 2309, 2375; PWT L-159, LB-2253; Wislizenus 524.*

Lonicera ×*bella* Zabel, (M). (F) Roadside escape. *2176, 2181.*

L. canadensis Marshall, Fly Honeysuckle (M, S). (O) Northern hardwoods. *1538, 2038; WRO 1509.*

L. dioica L., Wild Honeysuckle (M, S). (O) Northern hardwoods. *1234, 3958, 4269; PWT L-128, L-187, L-1878.*

L. hirsuta Eaton, Hairy Honeysuckle (M, S). (O) Coastal forests. *2020, 4347; WRO 1612; PWT L-919.*

L. morrowii A. Gray, (M). (F) Roadside escape. *2194, 3537.*

L. tatarica L., Tartarian Honeysuckle (M). (F) Roadside escape. *3918.*

L. xylosteum L., European Fly Honeysuckle (M). (F) Escape at old Air Force Station. *2177.*

Sambucus canadensis L., Common Elder (M). (O) Wet fields and roadsides. *2556, 3392, 3404.*

S. pubens Michaux, Red Elderberry (M, S, N). (O) Northern hardwoods. *1422, 1518, 3939; WRO 37, 571.*

Symphoricarpos albus (L.) S.F. Blake, Snowberry (M, S, N). (F) Coastal forests. *1765a, 1785, 1832, 2953; WRO 264; PWT L-159, L-433; EGV 5149.*

Triosteum aurantiacum Bickn., Wild Coffee (M). (L) Along trail through Bow Lakes unit. *2348.*

Viburnum acerifolium L., Maple-leaved Viburnum (M, S, N). (C) Northern hardwoods. *1524, 2301, 2331, 2371; PWT L-917, L-1557; Wislizenus 528.*

V. lentago L., Nannyberry (M). (O) Swales. *3177, 3442.*

V. trilobum Marshall, Highbush Cranberry (M, S). (F) Coastal forests and some northern hardwoods. *1347, 2208, 2933, 3178; PWT L-1571, L-1699.*

CARYOPHYLLACEAE (Pink Family)

Agrostemma githago L., Corn-cockle (M, N). (L) Disturbed ground and roadsides. Most common in old field south of Stormer Rd. *2552, 3428, 4117.*

Arenaria serpyllifolia L., Thyme-leaved Sandwort (M, S, N). (C) Disturbed ground. *1270, 1462, 2104, 2150.*

A. stricta Michaux, Rock Sandwort (M, S, N). (C) Dunes and sandy soil. *1301, 1429, 2241, 2282, 4500; WRO 261; PWT L-940; LB-2255.*

Cerastium fontanum Baumg., Common Mouse-eared Chickweed (M, S, N). (F) Disturbed ground. *1351, 1378, 2103, 2736, 2781; PWT L-91, L-819.*

C. semidecandrum L., (M, S). (L) Disturbed ground at Innisfree; South Manitou two-track. *4760; Reznicek 8183.*

C. tomentosum L., Snow-in-summer (M, N). (L) Escaping and spreading from cultivation. *1410, 2146, 2196; WRO 1900.*

Dianthus armeria L., Deptford Pink (M, S). (O) Old fields. *1539, 3399, 3463.*

D. barbatus L., (M, S). (L) Persisting and spreading slightly from cultivation. *2404, 2449; WRO 2861.*

D. deltoides L., (M). (L) Old field along Pyramid Point trail. *2321.*

D. plumarius L., Garden Pink (M, N). (O) Escaping and spreading from cultivation along roadsides. *1596, 2459, 3258, 3277, 4042.*

Gypsophila paniculata L., Baby's-breath (M). (O) Dunes and roadsides. *2473, 2589, 3551.*

Lychnis coronaria (L.) Desr., Mullein Pink (M, N). (L) Disturbed ground and roadsides. *1702, 2508, 2529.*

Saponaria officinalis L., Bouncing Bet (M, S, N). (F) Old fields and some dunes. *1769, 2586, 2645, 2729.*

Silene antirrhina L., Sleepy Catchfly (M, S, N). (O) Sandy disturbed areas, and on dunes. *2504, 4149, 4206, 4371, 4376; WRO 1200; PWT L-962, L-1313, LB-2254.*

S. armeria L., Sweet-William Catchfly (M). (L) Along trails in coastal forest south of Platte River. *3456; WRO 2700.*

S. dichotoma Ehrh., (M). (L) Clay bank near corner of M-22 and Sutter Rd. *WRO 1503* (Collected by H. Gall).

S. pratensis (Rafn) Godron & Gren., White Campion (M, S, N). (F) Old fields. *1543, 1634, 2314, 2384; EGV 5159.*

S. vulgaris (Moench) Garcke, Bladder Campion (M, S, N). (C) Old fields, roadsides, and dunes. *1248, 1310, 1447, 2357, 2413; PWT L-191; EGV 5161.*

Stellaria graminea L., Common Stitchwort (M, N). (O) Old fields. *1405, 1496, 2250.*
S. media (L.) Villars, Common Chickweed (M, S, N). (F) Trails and roadsides. *1424, 2386, 2536, 2688, 3664.*

CELASTRACEAE (Staff-tree Family)
Celastrus scandens L., Bittersweet (M, S, N). (O) Old fields. *1412, 1789, 3666, 3863; PWT L-1562.*

CERATOPHYLLACEAE (Hornwort Family)
Ceratophyllum demersum L., Coontail (M). (F) Lakes and streams. *4474, 4717.*

CHENOPODIACEAE (Goosefoot Family)
Chenopodium album L., Lambs-quarters (M, S, N). (F) Disturbed ground. *1742, 2598, 2622, 2800, 4499, 4799; PWT L-1226.*
C. capitatum (L.) Asch., Strawberry Blite (M, N). (L) Roadsides. *2452a; WRO 2113; Transeau.*
Corispermum hyssopifolium L., Bugseed (M, S, N). (O) Dunes. *1880, 2811; WRO 2698; PWT L-1733; EGV 5137.*
Cycloloma atriplicifolium (Sprengel) J. Coulter, Winged Pigweed (M). (O) Disturbed ground. *2923, 2959.*

CISTACEAE (Rockrose Family)
Helianthemum canadense (L.) Michaux, Frostweed (M). (O) Coastal forests and open relict dune ridges. *2291, 2418; WRO 15; PWT LB-2356.*
Hudsonia tomentosa Nutt., Beach Heath (M, N). (F) Dunes. *1656, 2287, 2363; WRO 19.*

COMPOSITAE [ASTERACEAE] (Composite Family)
Achillea millefolium L., Common Yarrow (M, S, N). (F) Old fields and roadsides. *1253, 2507, 2555, 2960, 4535; EGV 5156.*
Ambrosia artemisiifolia L., Common Ragweed (M, S, N). (F) Disturbed ground and roadsides. *1849, 1898, 2914, 2967.*
A. psilostachya DC., (M, S, N). (F) Old fields and roadsides. *1685, 3684, 3860, 4734; EGV 5130.*
Anaphalis margaritacea (L.) Benth. & Hook., Pearly Everlasting (M, S, N). (C) Old fields and roadsides. *1593, 1788, 2937, 3007; WRO 256; PWT L-950.*
Antennaria neglecta E. Greene, Field Pussytoes (M, S, N). (C) Old fields. *1288, 1442, 2088, 2191, 3050, 3905, 3914, 4119, 4138; WRO 917.*
A. plantaginifolia (L.) Richardson, (M, S, N). (C) Old fields. *3044, 3891, 3903, 3904, 3915, 4202.*
Arctium minus Schk., Common Burdock (M, S, N). (F) Disturbed ground and roadsides. *1866, 2746, 2911, 4802.*
Artemisia caudata Michaux, Wormwood (M, S, N). (C) Dunes. *1831, 1904, 2767, 2835; WRO 622; PWT L-380, L-569; EGV 5150.*
Aster ciliolatus Lindley, (S). (L) Trail near Cedars, South Manitou. *1917.*
A. dumosus L., (M). (L) Marsh along Good Harbor Bay, Cleveland Township Section 4. *PWT L-1640.*
A. laevis L., Smooth Aster (M, S). (C) Dunes and roadsides. *1736, 1871, 1899, 2814, 3008, 3639, 3857, 3866a, 3884; PWT L-1421, L-1664.*
A. lateriflorus (L.) Britton, (M, S, N). (F) Black ash swamps, stream edges, and roadsides. *1836, 1893, 2984, 4813; PWT L-674.*
A. macrophyllus L., Large-leaved Aster (M, S, N). (F) Coastal forests. *1799, 2763, 2836, 3865, 4790.*
A. novae-angliae L., New England Aster (M). (L) Ditch along Co. Rd. 669. *4822.*
A. puniceus L., (M). (L) Roadside ditch near Round Lake; M-22 bog. *2982; PWT L-1123.*
A. sagittifolius Willd., (M). (L) Woods near M-22 bog. *PWT L-670, L-1124.*
A. simplex Willd., Panicled Aster (M, S). (C) Old fields and roadsides. *1806, 1883, 2944, 2985, 3004, 3864, 3882, 3889, 3890.*

Bidens cernuus L., Bur Marigold (M). (O) Edges of lakes and streams. *4718; WRO 1512.*

B. connatus Muhlenb., Bur Marigold (M). (O) Black ash swamps and edges of lakes and streams. *1782, 2996.*

Centaurea diffusa Lam., (M, N). (F) Old fields and roadsides. *1779, 2572, 2671, 2810; PWT L-1100.*

C. maculosa Lam., Spotted Knapweed (M, S, N). (C) Old fields and roadsides. *1592, 1733, 2585, 2632.*

Chrysanthemum leucanthemum L., Ox-eye Daisy (M, S, N). (C) Old fields and roadsides. *1252, 1377, 2231, 2335; WRO 26.*

Cichorium intybus L., Common Chicory (M, N). (O) Old fields and roadsides. *1847, 2548, 2577.*

Cirsium arvense (L.) Scop., Canada Thistle (M, S, N). (F) Roadsides, swales, and lake edges. *1591, 1755, 2563, 2658, 4318; PWT L-1420.*

C. muticum Michaux, (M). (F) Swales and cedar swamps. *3613, 4444, 4683.*

C. pitcheri (Torrey) Torrey & A. Gray, Pitcher's Thistle (M, S, N). (F) Dunes. *1367, 1585, 2628, 3480; Engelmann; WRO 114; PWT L-540, L-647; EGV 5135; Wislizenus 544.*

C. vulgare (Savi) Tenore, Bull Thistle (M, S, N). (C) Old fields and roadsides. *1838, 2564, 2635, 3590, 4497; PWT L-459.*

Conyza canadensis (L.) Cronq., Hog Weed (M, S, N). (O) Disturbed ground and roadsides. *1845, 1914, 2795, 2965.*

Coreopsis lanceolata L., Lance-leaved Coreopsis (M, S, N). (C) Dunes. *1282, 1372, 1494, 2359, 2501; WRO 30; PWT L-220, L-1275; Wislizenus 541.*

Erechtites hieracifolia (L.) Raf., (M). (L) Cleared area in ravine, Centerville Township Section 6. *PWT L-1660.*

Erigeron annuus (L.) Pers., (M, S). (C) Old fields and roadsides. *1863, 2476, 2513, 2798.*

E. philadelphicus L., (S, N). (O) Moist open sites. *1317, 4153.*

E. strigosus Muhlenb., (M, S, N). (C) Old fields and roadsides. *1531, 2421, 2590, 3400, 3636, 3887, 4549.*

Eupatorium maculatum L., Joe-pye-weed (M). (F) Marshes and edges of lakes and streams. *2888, 3544, 4483.*

E. perfoliatum L., Boneset (M, S). (F) Marshes and edges of lakes and streams. *1752, 2871, 3545.*

Grindelia squarrosa (Pursh) Dunal, Curlycup Gumweed (M). (L) Roadsides near Port Oneida and along M-22 near South Dune Rd. *2643, 3012.*

Helianthus divaricatus L., Woodland Sunflower (M). (L) Along M-22 near Bass Lake (Leelanau Co.). *2958.*

H. giganteus L., Tall Sunflower (M). (L) In field along two-track north of North Bar Lake. *4840.*

Hieracium aurantiacum L., Orange Hawkweed (M, S, N). (F) Old fields and roadsides. *1341, 1439, 2230, 2320.*

H. canadense Michaux, (M). (O) Disturbed ground and coastal forests. *2780, 2813, 2889; WRO 643, 2295; PWT L-1639.*

H. piloselloides Villars, King Devil (M, S, N). (C) Old fields and roadsides. *1340, 1433, 2235, 2318; WRO 12; PWT LB-2313.*

H. scabrum Michaux, (N). (L) Edge of field at Bourniques, North Manitou. *4561a.*

H. venosum L., Rattlesnake Weed (M). (O) Roadsides and some dunes. *2362, 2595.*

Inula helenium L., (M). (L) Disturbed ground at Aral. *4452; WRO 250, 2676.*

Krigia virginica (L.) Willd., Dwarf Dandelion (M, S, N). (O) Disturbed sandy soil of coastal forests. *1360, 1438, 2344, 2420; WRO 680; PWT LB-2301.*

Lactuca biennis (Moench) Fern., Blue Lettuce (M, S). (O) Roadsides and trails. *1764, 4836, 4843.*

L. canadensis L., Wild Lettuce (M, S, N). (F) Roadsides. *2906, 3501, 3674, 4789, 4795, 4818, 4821, 4835, 4850.*

L. hirsuta Muhlenb., Hairy Lettuce (M). (L) Coastal forest near Old Indian trail. *2757.*

Lapsana communis L., Nipplewort (M). (L) Roadsides near Tucker Lake and along M-22 south of Esch Rd. *4245, 4844.*

Matricaria matricarioides (Less.) Porter, Pineapple Weed (M). (O) Roadsides. *3526, 4370.*

Megalodonta beckii (Torrey) E. Greene, Water-marigold (M). (L) Platte River. *4846.*

Prenanthes alba L., White Lettuce (M, S). (F) Coastal forests. *1776, 2887, 2949, 3671; WRO 642; PWT L-1874.*

Rudbeckia hirta L., Black-eyed Susan (M, S, N). (F) Old fields and roadsides. *1529, 1686, 2443, 2785.*

Senecio pauperculus Michaux, Balsam Ragwort (M, S, N). (F) Dunes and shores. *1309, 1373, 2389, 2463, 3234; WRO 14, 685; PWT LB-2391.*

Solidago caesia L., Blue Stem Goldenrod (M, S, N). (F) Trails and roadsides. *1925, 2979, 3010, 3023, 3866, 3886, 4807.*

S. canadensis L., Canada Goldenrod (M, S, N). (C) Old fields and roadsides. *1805, 1870, 1888, 1905, 2917, 2976, 3005, 3021, 3856, 3867, 3883, 3885, 3888, 4573.*

S. flexicaulis L., Zig-zag Goldenrod (M, S, N). (C) Northern hardwoods and coastal forests. *2926, 4495, 4796, 4841.*

S. gigantea Aiton, (M, S, N). (O) Old fields and woods edges. *1865, 3635, 3869, 4797; PWT L-1663.*

S. graminifolia (L.) Salisb., Grass-leaved Goldenrod (M, S). (F) Swales, lake edges, and roadside ditches. *1885, 2824, 2943, 3644; WRO 257, 616; PWT L-654.*

S. hispida Muhlenb., (M). (L) Coastal forest along Good Harbor Bay. *3883; PWT L-1223.*

S. nemoralis Aiton, Gray Goldenrod (M, S, N). (F) Dunes, old fields, and roadsides. *1772, 1833, 1842a, 2995, 3006, 3020; PWT L-568, L-687.*

S. rugosa Miller, Pyramid Goldenrod (M, S, N). (O) Edges of lakes and streams; some old fields. *1819, 1841, 2890, 3022, 4676.*

S. spathulata DC., (M, S). (F) Dunes. *1712, 2941, 2955, 3640.*

S. uliginosa Nutt., (M). (L) Otter Creek cedar swamp. *2877.*

S. ulmifolia Muhlenb., (M). (L) Otter Creek cedar swamp. *3607.*

Sonchus arvensis L., (M). (L) Along Lake Michigan near Pyramid Point. *PWT L-1276.*

S. uliginosus M. Bieb., (M, N). (F) Fields and roadsides. *2591, 2669, 2840, 4270, 4506; PWT L-1548.*

Taraxacum officinale Weber, Dandelion (M, S, N). (C) Trails, roadsides, fields, and dunes. *1263, 1430, 2037, 2124.*

Tragopogon dubius Scop., Goat's Beard (M, S, N). (C) Old fields and roadsides. *1363, 1448, 2259, 2403.*

T. porrifolius L., Salsify (M). (L) Roadside along M-22 and Co. Rd. 651. *PWT L-859.*

T. pratensis L., (M). (L) Roadsides near intersection of M-22 and M-109. *2401; PWT L-887.*

CONVOLVULACEAE (Morning Glory Family)

Convolvulus arvensis L., Field Bindweed (M, N). (O) Old fields. *1500, 2848, 4265.*

C. sepium L., (M, S). (O) Old fields. *2526a, 2691, 2809; PWT L-914.*

CORNACEAE (Dogwood Family)

Cornus alternifolia L. f., Pagoda Dogwood (M, S, N). (O) Coastal forests and northern hardwoods. *1345, 1391, 2332, 2376; PWT L-140.*

C. amomum Miller, Silky Dogwood (M, S). (O) Swales and edges of lakes and streams. *2514, 3443, 4107; LB-2331.*

C. canadensis L., Bunchberry (M, S, N). (C) Cedar swamps and black ash swamps. *1258, 2263, 2895, 3568, 4162; Wislizenus 523.*

C. foemina Miller, (M). (L) Shore of Platte River. *WRO 2428.*

C. rugosa Lam., Round-leaved Dogwood (M, S, N). (F) Coastal forests. *1719, 2368, 3486; PWT L-1560; WRO 245.*

C. stolonifera Michaux, Red-osier (M, S, N). (C) Dunes and swales. *1305, 2171, 2203, 2942, 3179; Engelmann; WRO 100, 300; EGV 5151; Wislizenus 948.*

CRASSULACEAE (Orpine Family)

Sedum acre L., Mossy Stonecrop (M). (L) Roadsides near Glen Haven, and M-22 near Peterson Rd. *2288, 2515.*

S. album L., (M, S). (O) Disturbed sites and often spreading from cultivation. *1513, 2437, 2613, 3459.*

S. telephium L., Live-forever (M, S, N). (O) Persisting at former homesites. *1920, 3657, 3859; WRO 2860.*

CRUCIFERAE [BRASSICACEAE] (Mustard Family)

Alyssum alyssoides (L.) L., Pale Alyssum (M, S, N). (O) Roadsides. *1997, 2107, 2118, 4336; WRO 2902.*

Arabidopsis thaliana (L.) Heynh., (M). (O) Sandy fields. *2096, 3268; WRO 593.*

Arabis canadensis L., (M). (L) Northern hardwoods woodlot off Co. Rd. 651. *3523.*

A. divaricarpa Nelson, (M). (L) Old field near Old Indian Trial parking area. *3223.*

A. drummondii A. Gray, (M, S). (F) Old fields and roadsides. *1569, 2086, 2209, 3038.*

A. glabra (L.) Benth., Tower Mustard (M). (L) Alligator Hill. *PWT L-1859.*

A. holboellii Hornem., Holboell's Mustard (M, S, N). (O) Coastal dunes of Manitou Islands, Good Harbor Bay, and near Glen Haven. *1302, 1653, 2095, 3655, 4204; PWT L-1841.*

A. lyrata L., Sand Cress (M, S, N). (C) Dunes. *1303, 1437, 2034, 2125, 3927; PWT L-62; EGV 2237, 9879, 9907; WRO 557; Wislizenus 908.*

Barbarea vulgaris R. Br., Yellow Rocket (M, S, N). (F) Disturbed ground and roadsides. *1357, 1998, 2109, 2122, 2167.*

Berteroa incana (L.) DC., Hoary Alyssum (M, S, N). (C) Old fields and roadsides. *1458, 1549, 2149, 2313, 3604; EGV 5155.*

Brassica kaber (DC.) Wheeler, Charlock (M). (L) Bluff at end of Kelderhouse Rd. *3877, 4068.*

B. rapa L., Field Mustard (M). (L) Roadside escape. *PWT L-363.*

Cakile edentula (Bigelow) Hook., Sea-rocket (M, S, N). (C) Dunes. *1730, 2771, 2875; WRO 99; PWT L-430; EGV 1015, 5142.*

Camelina microcarpa DC., (S). (L) Disturbed ground of new maintenance area on South Manitou. *4334.*

Capsella bursa-pastoris (L.) Medikus, Shepherd's Purse (M, S, N). (F) Old fields and roadsides. *1343, 1483, 2108, 3029.*

Cardamine bulbosa (Muhlenb.) BSP., (M). (L) Edge of Otter Creek at Aral. *WRO 789.*

C. pensylvanica Willd., (M, N). (O) Along small shaded streams and swales. *2166, 3909, 4137, 4509.*

Dentaria diphylla Michaux, Two-leaved Toothwort (M, S, N). (F) Northern hardwoods. *1286, 1476, 1930, 1977, 2144, 2212; EGV 9983A.*

D. laciniata Willd., Cut-leaved Toothwort (M, S, N). (O) Northern hardwoods. *1950, 1980, 2145.*

Descurainia pinnata (Walter) Britton, (M). (L) Parking area for Empire Bluffs trail. *3052.*

Diplotaxis muralis (L.) DC., (M). (L) Disturbed ground near original entrance to the Scenic Drive. *4828.*

Erophila verna (L.) Besser, Whitlow-grass (M, S). (L) Roadsides at Platte River Campground and group campground north of Dune Climb; two-track near cemetery, South Manitou. *4738, 4745, 4752.*

Erysimum cheiranthoides L., Wormseed Mustard (M, N). (F) Disturbed ground and roadsides. *1697, 2733, 2924, 2968, 2990, 3190; WRO 952.*

Hesperis matronalis L., Dame's Rocket (M). (L) Roadsides. Especially spreading along M-109 at junction with M-22. *2175, 3470; PWT L-2309a, L-2309b*

Lepidium campestre (L.) R. Br., (M, S). (F) Old fields and roadsides. *2106, 2117, 3236, 3252, 4331; WRO 11, 790, 2152; PWT LB-2297.*

L. densiflorum Schrader, (M, S, N). (C) Disturbed ground and roadsides. *1495, 1745, 2920, 4332; WRO 312, 791.*

L. virginicum L., (M). (O) Disturbed ground. *3591, 3678, 4354.*

Lunaria annua L., Money-plant (M). (L) Roadside escape near Inspiration Point. *2084.*

Nasturtium officinale R. Br., Watercress (M). (F) Roadside ditches, swales, and stream edges. *2470, 2981, 3249, 4179, 4343; WRO 433.*

Rorippa palustris (L.) Besser, Field Mustard (M, S). (F) Lake edges and swales. *1882, 2427, 2499, 2651; PWT L-412.*

Sisymbrium altissimum L., Hedge Mustard (M, S, N). (C) Old fields and roadsides. *1497, 1915, 2207, 2315, 2356, 2435, 4353; WRO 765, 1001; PWT L-1871.*

S. officinale (L.) Scop., Hedge Mustard (M). (O) Disturbed ground and roadsides. *3433, 4382; PWT L-364.*

DROSERACEAE (Sundew Family)

Drosera rotundifolia L., Sundew (M, N). (L) Bogs. *2714, 2852, 3617; WRO 394a.*

ELAEAGNACEAE (Oleaster Family)

Shepherdia canadensis (L.) Nutt., Buffaloberry (M, S). (F) Dunes and shores. *1338, 2874, 3478; EGV 1014, 2897.*

ERICACEAE [Sensu lato] (Heath Family)

Andromeda glaucophylla Link, Bog Rosemary (M). (L) Bogs. *2223; WRO 393; PWT L-48.*

Arctostaphylos uva-ursi (L.) Sprengel, Bearberry (M, S, N). (C) Dunes and jack pine stands. *1558, 2060, 3653; Engelmann; WRO 105, 558; PWT L-61, L-737; Wislizenus 553.*

Chamaedaphne calyculata (L.) Moench, Leatherleaf (M, N). (F) Bogs and swales. *1419, 2077, 2169, 2343; PWT L-50, L-1579.*

Chimaphila maculata (L.) Pursh, Spotted Wintergreen (M). (R) Moist woods south of M-22 west of Saffron Rd. *3669.* Michigan special concern species.

C. umbellata (L.) Barton, Pipsissewa (M, S, N). (O) Coastal forests. *1740, 3933; WRO 112; PWT L-918, LB-2262; Wislizenus 556.*

Epigaea repens L., Trailing Arbutus (M). (O) Coastal forests. *2042, 2064; PWT L-49.*

Gaultheria hispidula (L.) Muhlenb., Creeping Snowberry (M, N). (O) Bogs and cedar swamps. *1640, 2851, 2894; WRO 392; PWT L-669.*

G. procumbens L., Wintergreen (M, N). (O) Coastal forests. *2723, 2754, 4281; Wislizenus 554; WRO 518.*

Gaylussacia baccata (Wangenh.) K. Koch, Huckleberry (M, N). (F) Coastal forests and bogs. *1418, 2202a, 4263; WRO 108; PWT L-580, L-1573.*

Kalmia polifolia Wangenh., Bog-laurel (M, N). (L) Bogs. *2224, 4127; PWT L-181.*

Ledum groenlandicum Oeder, Labrador Tea (M). (O) Swales and bogs. *2202b, 2853, 3279; PWT L-184.*

Moneses uniflora (L.) A. Gray, (S). (L) Jack pines near Garden City, South Manitou. *3211.*

Monotropa hypopithys L., Pine Sap (M, N). (O) Coastal forests and some northern hardwoods. *1649, 2303, 2525; WRO 396; PWT L-1642.*

M. uniflora L., Indian Pipe (M, S, N). (F) Coastal forests and northern hardwoods. *1703, 1724, 2641, 2755; WRO 251; Wislizenus 537; EGV 5123.*

Pterospora andromedea Nutt., Pine-drops (M). (L) Dunes/woods edge, Good Harbor Bay; jack pine stands, Aral. *3515; WRO 1417* (Collected by H. Gall). Michigan threatened species.

Pyrola asarifolia Michaux, Pink Pyrola (M, S). (O) Cedar swamps. *1262, 2488, 3271.*

P. chlorantha Sw., (M, N). (F) Cedar swamps and moist coastal forests. *1471, 2373, 2422, 2521, 3251, 3444; Englemann; WRO 689, 964.*

P. elliptica Nutt., Shinleaf (M, S, N). (O) Moist coastal forests. *1510, 1638; PWT L-936.*

P. rotundifolia L., (M). (O) Coastal forests. *2517; PWT L-892.*

P. secunda L., One-sided Pyrola (M, S, N). (O) Woods bordering dunes and shores, jack pine stands, and black ash swamp at Tamarack Lake, North Manitou. *1546, 1673, 3500; PWT L-956.*

Vaccinium angustifolium Aiton, Low Sweet Blueberry (M, N). (C) Coastal forests and bogs. *2063, 2817, 3920, 4563; WRO 120, 559; PWT L-51, L-796.*

V. macrocarpon Aiton, Large Cranberry (M, N). (L) Taylor Lake sedge mat; North Manitou. *4197; Wislizenus 552.*

V. myrtilloides Michaux, Velvet-leaf Blueberry (M, N). (F) Bogs and coastal forests. *1679, 2823, 3506; PWT L-581.*

V. oxycoccos L., Small Cranberry (M, N). (L) Bogs. *2226, 2519, 2717; WRO 395.*

EUPHORBIACEAE (Spurge Family)

Euphorbia cyparissias L., Cypress Spurge (M, N). (O) Roadsides. *1411, 2111, 2193; Wislizenus 591.*

E. esula L., Leafy Spurge (M). (F) Roadsides. *2119, 2139, 3253.*

E. glyptosperma Engelm., (M, N). (O) Roadsides. *2606, 2667, 2961, 4805; WRO 2284.*

E. polygonifolia L., Seaside Spurge (M, N). (L) Dunes. *4567; WRO 764; PWT L-423, L-1563; EGV 5138.*

FAGACEAE (Beech Family)

Castanea dentata (Marshall) Borkh., Chestnut (M, S, N). (L) Persisting behind sand pit near Glen Lake access off Day Forest Rd.; large tree just in woods at end of Sunset Trail Rd.; fine stand in woods south of Frank Farm, North Manitou. *1565, 1646, 2751.*

Fagus grandifolia Ehrh., Beech (M, S, N). (C) Northern hardwoods. *1402, 1530, 2467, 2732, 2975; Wislizenus.*

Quercus alba L., White Oak (M). (F) Coastal forests. *2885, 3934; WRO 429; PWT L-1103.*

Q. coccinea Muenchh., (M). (L) Coastal forest near Peterson Rd. *2994.*

Q. rubra L., Red Oak (M, S, N). (C) Coastal forests and some northern hardwoods. *1298, 1824, 2752, 2759, 2939, 2952, 2986, 3588; WRO 807; PWT L-973, L-1241, LB-2266.*

Q. ×palaeolithicola Trel., (M). (L) Coastal forest near Peterson Rd. *2940.*

Q. velutina Lam., (M). (O) Coastal forests of Platte Bay. *WRO 430.*

FUMARIACEAE (Fumitory Family)

Corydalis aurea Willd., Golden Corydalis (M). (L) Disturbed ground in northern hardwoods near Hidden Lake. *3907.*

C. sempervirens (L.) Pers., Pink Corydalis (M, S). (L) Along foundation of Coast Guard Station, South Manitou; disturbed area along Peterson Rd. *3594; Engelmann; WRO 1199.*

Dicentra canadensis (Goldie) Walp., Squirrel-corn (M, S, N). (C) Northern hardwoods. *1929, 1968, 2028, 2046.*

D. cucullaria (L.) Bernh., Dutchman's-breeches (M, S, N). (C) Northern hardwoods. *1935, 1963, 2031, 2047.*

GENTIANACEAE (Gentian Family)

Bartonia virginica (L.) BSP., Bartonia (M). (L) Wet woods between Kelderhouse Rd. and Port Oneida bog. *2815.*

Gentiana andrewsii Griseb., (M). (L) Glen Lake near Day Mill Pond. *4834; PWT L-1235; EGV 2865.*

G. procera Holm, Fringed Gentian (M). (L) Dune pools along road from Glen Haven to Coast Guard Station. *3015.*

G. rubricaulis Schwein., (M). (L) Shores of Crystal River. *PWT L-1870.*

Halenia deflexa (Smith) Griseb., (M). (L) Coastal forest near Otter Creek cedar swamp. *2882; WRO 522; PWT LB-2343.*

Menyanthes trifoliata L., Buckbean (M, N). (O) Bogs and sedge mats. *2705, 3171, 4408; WRO 397.*

GERANIACEAE (Geranium Family)

Erodium cicutarium (L.) L'Hér, Stork's-bill (M, N). (L) Disturbed ground near Day Forest Rd., and at North Manitou Village. *1449, 4381.*

Geranium pusillum L., (M). (F) Disturbed ground and roadsides. *2597, 2946, 3681, 4380.*

G. robertianum L., Herb-robert (M, S, N). (C) Northern hardwoods. *1327, 1606, 2161, 2213; EGV 5126; WRO 38, 306; Wislizenus 476.*

GROSSULARIACEAE (Gooseberry Family)

Ribes americanum Miller, Wild Black Currant (M). (O) Black ash swamps. *3894.*

R. cynosbati L., Wild Gooseberry (M, S, N). (F) Northern hardwoods. *1881, 1975, 2074, 2929; PWT L-888.*

R. glandulosum Grauer, (M). (L) Otter Creek. *WRO 1874* (Collected by H. Gall).

R. hudsonianum Richardson, (N). (L) Black ash swamp north of Lake Manitou. *4505.*

R. triste Pallas, (M). (L) Otter Creek cedar swamp. *2492.*

GUTTIFERAE [CLUSIACEAE] (St. John's-wort Family)

Hypericum kalmianum L., Kalm's St. John's-wort (M, S). (F) Swales, shores, and moist dunes. *1744, 2611, 4247; WRO 119, 460, 1247; PWT L-922, LB-2341.*

H. majus (A. Gray) Britton, (M, S). (O) Lake edges. *3654, 4306, 4387, 4465; PWT L-942.*

H. perforatum L., Common St. John's-wort (M, S, N). (C) Old fields and roadsides. *1528, 1587, 2446, 2457; EGV 5157.*

Triadenum fraseri (Spach) Gleason, Marsh St. John's-wort (M, N). (O) Swales; edges of lakes and streams. *2652, 2711, 2819, 4388, 4462; WRO 619, 1257; PWT L-1569, LB-1355.*

HALORAGACEAE (Water-milfoil Family)

Myriophyllum exalbescens Fern., (M, N). (C) Lakes and streams. *4253, 4431, 4515, 4518, 4527, 4584, 4590, 4705; PWT L-575.*

M. heterophyllum Michaux, (M). (O) Lakes and streams. *4454, 4698.*

M. spicatum L., (M, N). (L) Platte River, Loon Lake, and North Bar Lake. *4358, 4699, 4782, 4798.*

Proserpinaca palustris L., (M). (L) Shalda Creek swales. *4692; PWT L-413, L-1778.*

HAMAMELIDACEAE (Witch-hazel Family)

Hamamelis virginiana L. Witch-hazel (M). (F) Coastal forests. *2310, 2753.*

HIPPURIDACEAE (Mare's-tail Family)

Hippuris vulgaris L., Mare's-tail (M). (L) Otter Creek. *4433; WRO 1501.*

HYDROPHYLLACEAE (Waterleaf Family)

Hydrophyllum appendiculatum Michaux, (M, S). (O) Northern hardwoods. *1762, 3163; PWT L-879.*

H. virginianum L., (M). (O) Northern hardwoods. *2253, 3161; PWT L-882; EGV 9909.*

JUGLANDACEAE (Walnut Family)

Juglans regia L., English Walnut (N). (L) Spreading to beach near North Manitou Village. *4571.*

J. nigra L., Black Walnut (M). (O) Planted at former homesites, but sometimes spreading into adjacent old fields. *3484, 3534.*

LABIATAE [LAMIACEAE] (Mint Family)

Galeopsis tetrahit L., (M). (L) Pot Holes, North Manitou. *1694.*

Glechoma hederacea L., Gill-over-the-ground (M). (F) Disturbed ground. *2025, 2240, 3217.*

Hedeoma hispida Pursh, (M). (L) Old field near Pyramid Point. *Reznicek 7213.*

Leonurus cardiaca L., Common Motherwort (M, N). (F) Shaded trails and roadsides. *1669, 2673, 2744; WRO 247.*

Lycopus americanus Muhlenb., Water Horehound (M, S, N). (F) Swales and edges of

lakes and streams. *1607, 1749, 1809, 4240, 4486, 4577, 4689; WRO 620; PWT L-946.*

L. uniflorus Michaux, Bugle-weed (M, S, N). (C) Cedar swamps, black ash swamps, and lake edges. *1783, 1801, 2710, 2862, 2883, 3510, 3570, 3612, 4403, 4415, 4466, 4545.*

Mentha arvensis L., (M, S, N). (F) Cedar swamps and lake edges. *1754, 2899, 2950, 3549, 3623, 4313, 4341; WRO 1250; PWT L-1559.*

M. piperita L., (M, N). (O) Edges of lakes and streams. *4529, 4686.*

Monarda fistulosa L., Wild Bergamot (M). (O) Disturbed ground and roadsides. *2560, 2797, 3485; PWT L-1102.*

M. punctata L., Horsemint (M, S, N). (F) Dunes and old fields. *1594, 1778, 2608, 2624; PWT L-271; WRO 111; EGV 5164.*

Nepeta cataria L., Catnip (M, S, N). (O) Roadsides. *1650, 1876, 2550.*

Prunella vulgaris L., Self-heal (M, S, N). (F) Disturbed ground and roadsides. *1570, 1630, 2471, 2509.*

Pycnanthemum flexuosum (Walter) BSP., (M). (L) Wet field near Day Forest Rd. *4812.*

P. virginianum (L.) T. Durand & B.D. Jackson, (M). (L) Field near Narada Lake. *PWT L-915.*

Satureja acinos (L.) Scheele, (M). (F) Disturbed ground and roadsides. *2370, 2551, 2612, 3018; PWT L-2437.*

S. vulgaris (L.) Fritsch, Basil (M, S, N). (F) Disturbed ground and roadsides. *1525, 1597, 2372, 3398; PWT L-955, L-1568, L-1775.*

Scutellaria galericulata L., Common Skullcap (M, S, N). (F) Cedar swamps and swales. *1682, 1756, 2484, 2650, 3439, 4478; WRO 1248.*

S. lateriflora L., Mad Dog Skullcap (M, S, N). (F) Cedar swamps and black ash swamps. *1681, 1766, 1781, 2868, 4397, 4479; WRO 1249; EGV 5125.*

Stachys palustris L., (N). (L) Northern hardwoods near The Spring, North Manitou. *4550.*

Teucrium canadense L., Germander (M, S). (O) Moist roadsides and lake edges. *3531, 3579, 3659, 4316; PWT L-893, L-1602.*

LEGUMINOSAE [FABACEAE] (Bean Family)

Desmodium canadense (L.) DC., (M). (L) Old field south of Long Lake Rd. *3538; WRO 1272, 1389.*

Lathyrus japonicus Willd., Beach Pea (M, S, N). (C) Dunes and shores. *1295, 1370, 2769, 2833; Engelmann; WRO 262; EGV 5143; Wislizenus 484.*

L. latifolius L., Everlasting Pea (M, S). (F) Roadsides. *1795, 2402, 2531, 3471, 3482.*

L. palustris L., Marsh Pea (M). (O) Stream edges in cedar swamps and black ash swamps. *2485, 4238b, 4244; WRO 523.*

L. sylvestris L., Everlasting Pea (M). (O) Old fields. *2646, 2801.*

Lotus corniculata L., Birdfoot Trefoil (M). (L) Along M-22 near Port Oneida Rd. *3156.*

Medicago lupulina L., Black Medic (M, S, N). (F) Old fields and roadsides. *1364, 1451, 2283, 2294; PWT L-189.*

M. sativa L., Alfalfa (M, S, N). (F) Old fields and roadsides. *1516, 1541, 1631, 2561, 2647.*

M. ×*varia* Martyn, Yellow Alfalfa (M, S). (L) Old fields and roadsides. *1540, 2648, 3675.*

Melilotus alba Medikus, White Sweet Clover (M, S, N). (C) Old fields and roadsides. *1567, 1589, 1821, 2474, 2749; PWT L-565.*

M. officinalis (L.) Pallas, Yellow Sweet Clover (M, S, N). (F) Old fields and roadsides. *1629, 1820, 2272, 2358, 2475; PWT L-1113.*

Robinia pseudoacacia L., Black Locust (M, S, N). (F) Persisting and often spreading from former home sites. *1851, 1900, 2945, 3558; WRO 437.*

Trifolium arvense L., Rabbitfoot Clover (M). (L) Old field near corner of Sunset Trail and Thorson Rds. *2802.*

T. aureum Pollich, Hop Clover (M, N). (O) Old fields. *1628, 3403, 3576, 4142.*

T. hybridum L., (M). (L) Trail through woods between Day Forest Rd. and Glen Lake. *2657.*

T. pratense L., Red Clover (M, S, N). (C) Old fields and roadsides. *1255, 1413, 2311, 4078; PWT L-564.*

T. repens L., White Clover (M, S, N). (C) Old fields and roadsides. *1245, 1441, 2257, 2312, 2574, 2803, 4512.*

Vicia sativa L., Common Vetch (N). (L) Stormer Place clearing, North Manitou. *1661.*

V. tetrasperma (L.) Schreber, Sparrow Vetch (M). (L) Old field off Sunset Trail Rd. *2807.*

V. villosa Roth, Hairy Vetch (M, S, N). (C) Old fields and roadsides. *1244, 1445, 3942.*

LENTIBULARIACEAE (Bladderwort Family)

Utricularia cornuta Michaux, Horned Bladderwort (M). (O) Dune pools and sedge mats. *2766; PWT LB-2339.*

U. geminiscapa Benj., (M). (O) Bog ponds. *4377, 4390.*

U. gibba L., (M). (R) Hidden Lake. *PWT L-1419.*

U. intermedia Hayne, Flat-leaved Bladderwort (M, N). (L) Otter Creek; North Manitou. *WRO 1658; Wislizenus 559.*

U. minor L., (M). (F) Lakes and swales. *3949, 4097, 4471, 4702.*

U. vulgaris L., (M). (C) Lakes and swales. *3948, 4045a, 4113, 4190, 4218, 4226; WRO 1611; PWT L-1341.*

LOBELIACEAE (Lobelia Family)

Lobelia cardinalis L., Cardinal Flower (M). (O) Wet woods along swales and streams. *2867, 2930.*

L. inflata L., Indian Tobacco (M, S). (O) Swales and some northern hardwoods. *1802, 2897, 2910, 4810.*

L. kalmii L., Kalm's Lobelia (M, S). (F) Dune pools and shores. *1579, 1746, 2765, 3014, 4365; WRO 521; PWT L-407, L-938.*

L. siphilitica L., (M). (L) Shore near Glen Lake beach. *4688.*

L. spicata Lam., (M, S). (L) Old field near perched dunes South Manitou; jack pine stand, Aral Dunes. *2685; PWT LB-2340.*

LYTHRACEAE (Loosestrife Family)

Decodon verticillatus (L.) Elliott, Swamp Loosestrife (M). (F) Edges of lakes and steams. *2850, 4716, 4724; WRO 527.*

Lythrum salicaria L., Purple Loosestrife (M). (O) Along Platte River, edge of School Lake, and in a roadside ditch north of Esch Rd. *2676, 4360, 4458, 4482; WRO 618.*

MALVACEAE (Mallow Family)

Malva moschata L., Musk Mallow (M). (L) Along M-22 near Glen Lake beach. *2461.*

M. neglecta Wallr., Common Mallow (M, S). (O) Disturbed ground and roadsides. *1797, 2846, 3183, 3663, 3679.*

MYRICACEAE (Bayberry Family)

Myrica gale L., Sweet Gale (M). (F) Swales and edges of lakes and streams. *2199, 2543, 3897.*

NYCTAGINACEAE (Four-o'clock Family)

Mirabilis hirsuta (Pursh) MacMillan, (M). (L) Old field, Empire Township Section 6. *PWT L-1601.*

M. nyctaginea (Pursh) MacMillan, (M). (L) Along M-22 near Sutter Rd. *2472.*

NYMPHAEACEAE (Water-lily Family)

Brasenia schreberi J. Gmelin, Water-shield (M). (L) Taylor Lake, and pond near Port Oneida bog. *4720.*

Nuphar variegata Durand, Pond-lily (M, N). (C) Lakes and streams. *4189, 4213, 4521; WRO 432; PWT L-1338.*

Nymphaea odorata Aiton, Water-lily (M). (F) Lakes and streams. *4188, 4200, 4214; WRO 459, 610.*

OLEACEAE (Olive Family)

Fraxinus americana L., White Ash (M, S, N). (C) Northern hardwoods. *1526, 1619, 2725, 3589; PWT L-925.*

F. nigra Marshall, Black Ash (M, S, N). (C) Black ash swamps and edges of lakes and streams. *1670, 1798, 4394, 4586; PWT L-1561.*

F. pennsylvanica Marshall, Red Ash (M). (F) Lake edges. *4223, 4710; PWT L-409, L-410.*

Syringa vulgaris L., Lilac (M, S, N). (F) Persisting and sometimes spreading from former home sites. *1280, 1464, 2102, 3648.*

ONAGRACEAE (Evening Primrose Family)

Calylophus serrulatus (Nutt.) Raven, (M). (L) Old field at end of Greenan Rd. *2663; PWT L-1106, L-2376.*

Circaea alpina L., Dwarf Enchanter's Nightshade (M, S, N). (C) Cedar swamps and some northern hardwoods. *1573, 1622, 2479, 2860; WRO 2451; EGV 5119.*

C. lutetiana L., (M). (F) Northern hardwoods. *2478, 2535, 2636, 3422.*

Epilobium angustifolium L., Fireweed (M, S). (L) Roadsides: M-22 near Long Lake Rd., Miller Hill overlook, and on South Manitou. *1708, 3546, 4837.*

E. ciliatum Raf., (M, S, N). (O) Cedar swamps, black ash swamps, and lake edges. *1580, 3511; PWT L-939, L-1570.*

E. coloratum Biehler, (M, S). (O) Cedar swamps, marshes, and lake edges. *1815, 3615, 3622, 4489.*

E. leptophyllum Raf., (M, N). (O) Cedar swamps and black ash swamps. *2873, 2878, 4425, 4542; WRO 1657; PWT L-460.*

E. parviflorum Schreber, (M). (O) Cedar swamps, black ash swamps, and some roadsides. *2863, 3550, 3677.*

Ludwigia palustris (L.) Elliott, Water-purslane (M). (L) Swales along Shalda Creek and along inlet to School Lake. *4402, 4681.*

Oenothera biennis L., (M). (O) Disturbed ground and roadsides. *2989, 3592, 3610, 4811.*

O. clelandii W. Dietr., Raven, & W. L. Wagner, (M). (L) Roadsides: along School Lake Rd. and along M-22 near Old Indian trail. *2588, 3527.*

O. laciniata Hill, (M). (L) Along Day Forest Rd. *3220.*

O. oakesiana (A. Gray) S. Watson & J. Coulter, (M, S, N). (C) Dunes, some old fields, and roadsides. *1655, 1725, 2931, 3462, 3487, 4502; PWT L-378; EGV 5154.*

O. parviflora L., (M). (L) Old field at edge of Lutheran cemetery. *2957.*

OROBANCHACEAE (Broom-rape Family)

Conopholis americana (L.) Wallr., Squawroot (M, N). (O) Northern hardwoods. *1604, 2304; WRO 390.*

Epifagus virginiana (L.) Barton, Beech-drops (M, S, N). (C) Northern hardwoods. *1823, 1857, 3017; PWT L-948.*

Orobanche fasciculata Nutt., Broom-rape (M, S, N). (F) Dunes. *1292, 2462, 2464, 4151; WRO 297; PWT L-288, L-1312.* Michigan threatened species.

O. uniflora L., One-flowered Cancer-root (N). (L) Blowout edge, northwest side of North Manitou. *4150.*

OXALIDACEAE (Wood-sorrel Family)

Oxalis acetosella L., (M). (L) Wet woods south of M-22, west of Saffron Rd. *3668.*

O. fontana Bunge, (M, S, N). (C) Old fields and roadsides. *1647, 2617, 2745, 2774, 3584, 3658; PWT L-966.*

O. stricta L., (M, S, N). (C) Old fields and roadsides. *1527, 2197, 2297, 2603, 2686, 3181, 3638, 3661, 4155.*

PAPAVERACEAE (Poppy Family)

Sanguinaria canadensis L., Bloodroot (M, S, N). (F) Northern hardwoods. *1241, 4157, 4735; EGV 9891.*

PHRYMACEAE (Lopseed Family)

Phryma leptostachya L., Lopseed (M, S). (L) Rich northern hardwoods near perched dunes on South Manitou and at Pyramid Point; northern hardwoods along Echo Valley Rd. *2537, 2683, 3555.*

PHYTOLACCACEAE (Pokeweed Family)

Phytolacca americana L., Pokeweed (M). (L) Disturbed ground off M-22 near Deadstream Rd.; along Day Forest Rd. near Alligator Hill parking area. *2988, 3011.*

PLANTAGINACEAE (Plantain Family)

Plantago lanceolata L., English Plantain (M, S, N). (C) Old fields and roadsides. *1254, 1459, 2260, 2583; EGV 5162.*

P. major L., (M, S, N). (C) Old fields and roadsides. *1577, 2510, 2581, 2689, 3525; PWT L-1875.*

P. rugelii Decne., Pale Plantain (M, S, N). (F) Trails. *1643, 2684, 3621, 4838.*

POLEMONIACEAE (Phlox Family)

Phlox divaricata L., (M, N). (L) Old field along Scenic Drive; northern hardwoods along Old Grade, North Manitou. *4041, 4757; PWT L-1860; EGV 9908.*

P. subulata L., Moss-pink (M, N). (L) Spreading from cultivation: Trail's End Rd., Maple Grove Cemetery, North Manitou cemetery. *1981, 2147, 2198, 3902.*

POLYGALACEAE (Milkwort Family)

Polygala paucifolia Willd., Fringed Polygala (M, S, N). (F) Coastal forests and cedar swamps. *1257, 2087, 2132, 4554; WRO 342, 567.*

POLYGONACEAE (Smartweed Family)

Polygonella articulata (L.) Meissner, Jointweed (M). (L) Coastal forests along Good Harbor Bay; open relict shorelines along Peterson Rd. *2993; PWT L-1224, LB-2361; WRO 2696.*

Polygonum amphibium L., Water Smartweed (M, S). (F) Emergent from, and along edges of, lakes and streams. *1808, 3454, 4046, 4060, 4487, 4693, 4723; WRO 434.*

P. aviculare L., Knotweed (M, N). (O) Disturbed ground and roadsides. *2580, 3605, 4513, 4537.*

P. cilinode Michaux, Fringed False Buckwheat (M, S, N). (O) Lake edges and moist woods. *1328, 2970, 3468; Wislizenus 587.*

P. convolvulus L., Black-bindweed (M, S, N). (F) Disturbed ground and roadsides. *1648, 1843, 1907, 2602, 2618, 2804, 2808, 4551; EGV 5136.*

P. hydropiper L., Water-pepper (N). (L) Outlet of Lake Manitou near Pole Bridge. *4530.*

P. persicaria L., Lady's-thumb (M, S). (O) Disturbed ground, lake edges, and moist northern hardwoods. *1886, 2902, 2969, 3875; PWT L-937.*

P. punctatum Elliott, (M, S). (O) Edges of lakes and streams. *WRO 1251; PWT L-1858, LB-2348.*

Rumex acetosella L., Sheep Sorrel (M, S, N). (C) Old fields and roadsides. *1251, 1440, 2155, 2278; WRO 614; PWT L-1400, L-1858; Wislizenus.*

R. crispus L., Sour Dock (S, N). (F) Swales and black ash swamps. *1522, 1590.*

R. obtusifolius L., Bitter Dock (M, S, N). (O) Roadsides, old fields, and black ash swamps. *1586, 2527b, 2672, 3513, 4400; PWT L-1551, LB-2332.*

R. orbiculatus A. Gray, Water Dock (M). (O) Shores of lakes and streams. *4696.*

PORTULACACEAE (Purslane Family)

Claytonia caroliniana Michaux, Spring Beauty (M, S, N). (C) Northern hardwoods. *1928, 1967, 2029, 2045; WRO 575.*

Portulaca oleracea L., Common Purslane (M, S). (F) Disturbed ground and roadsides. *1919, 2919, 2962.*

PRIMULACEAE (Primrose Family)

Lysimachia ciliata L., (M). (L) Along Shell Lake. *PWT L-1777.*

L. terrestris (L.) BSP., Swamp Candle (M, S). (L) Port Oneida bog and south end of Lake Florence. *1582, 2821, 4421; PWT L-408.*

L. thyrsiflora L., Tufted Loosestrife (M, S, N). (F) Swales, cedar swamps, and black ash swamps. *1420, 2284, 2365, 3273, 3423, 4101; WRO 314; PWT LB-2287.*

Trientalis borealis Raf., Star Flower (M, S, N). (F) Northern hardwoods and coastal forest. *1231, 1636, 2133, 2170; PWT L-821.*

RANUNCULACEAE (Buttercup Family)

Actaea pachypoda Elliott, White Baneberry (M, S). (F) Northern hardwoods. *1767, 2788, 2841, 4378; WRO 303; PWT L-959, L-1848.*

A. rubra (Aiton) Willd., Red Baneberry (S, N). (L) Northern hardwoods. *1864, 4754.*

Anemone canadensis L., Canada Anemone (M). (L) Shady trails, Bow Lakes; roadside at Otter Creek near Aral. *2352, 3186; WRO 304.*

A. cylindrica A. Gray, Thimbleweed (M, S, N). (F) Old fields and roadsides. *2369, 2677, 2681, 3401, 3465, 4548.*

A. multifida Poiret, Red Anemone (M, S, N). (C) Dunes. *1431, 1554, 4249; PWT L-1846; EGV 1016, 5148.*

A. quinquefolia L., Wood Anemone (M, S). (L) Northern hardwoods at base of bluff south of Sleeping Bear Bluffs; Cedars, South Manitou. *2012, 2037b.*

A. virginiana L., (M). (L) Roadside near Otter Creek. *2216.*

Aquilegia canadensis L., Wild Columbine (M, S, N). (C) Cedar swamps, coastal forests, northern hardwoods, and shores. *1267, 1376, 2140, 2187; WRO 34; EGV 9880.*

Caltha palustris L., Marsh-marigold (M, N). (F) Shaded streams and roadside ditches. *1444, 2067, 2168.*

Clematis virginiana L., Woodbine (M). (L) Cedar swamp near Marl Springs; swales of Shalda Creek. *3245, 4823.*

Coptis trifolia (L.) Salisb., Goldthread (M, N). (O) Cedar swamps and black ash swamps. *1637, 2070, 2234.*

Hepatica acutiloba DC., Sharp-leaved Hepatica (M, S, N). (C) Northern hardwoods. *1285, 1934, 2027, 2043, 4152; PWT L-930; EGV 9889.*

H. americana (DC.) Ker Gawler, Round-leaved Hepatica (M, N). (O) Coastal forests. *2036, 3237, 4568; WRO 344; Wislizenus.*

Ranunculus abortivus L., Small-flowered Buttercup (M, S, N). (F) Northern hardwoods. *1239, 1489, 2048, 3047; EGV 9898.*

R. acris L., Common Buttercup (M, S, N). (C) Old fields and roadsides. *1261, 1354, 1397, 2151, 2195, 2980.*

R. bulbosus L., (N). (L) Grassy road, North Manitou Village. *1958.*

R. longirostris Godron, White Water Crowfoot (M, N). (L) Otter Creek; Lake Manitou. *4520, 4712.*

R. pensylvanicus L. f., Bristly Crowfoot (M). (L) Bow Lakes bog. *2901, 4386.*

R. recurvatus Poiret, Hooked Crowfoot (M, S). (F) Lake edges, black ash swamps, and moist northern hardwoods. *1953, 2112, 2162; PWT L-957; EGV 9899.*

R. reptans L., Creeping Spearwort (S). (L) Shores of Lake Florence. *1348, 2014; PWT L-953.*

R. sceleratus L., Cursed Crowfoot (M, S). (L) Shores of Narada Lake and Lake Florence. *1329, 4849.*

Thalictrum dasycarpum Fischer & Avé-Lall., Purple Meadowrue (M). (L) Shores of Platte River and Loon Lake. *4180.*

T. dioicum L., Early Meadowrue (M, S). (O) Northern hardwoods. *1314, 2035; WRO 388; EGV 9903.*

RHAMNACEAE (Buckthorn Family)

Ceanothus americanus L., New Jersey Tea (M). (L) Coastal forests along Platte Bay and Good Harbor Bay. *PWT L-421.*

C. herbaceus Raf., New Jersey Tea (M). (L) Coastal forest, Good Harbor Bay. *2364, 3458; PWT L-219.*

ROSACEAE (Rose Family)

Agrimonia gryposepala Wallr., (M, N). (O) Woods edges. *2905, 3016, 3393, 4791; WRO 520.*

Amelanchier arborea (Michaux f.) Fern., (M, S). (O) Coastal forests. *1944; PWT L-758.*

A. interior Nielsen, (M, S, N). (F) Coastal forests. *1721, 1976, 2075, 2127, 3032, 3036, 3896, 3901, 4340, 4739, 4741, 4742, 4743; WRO 1141.*

A. laevis Wieg., (M, S, N). (O) Coastal forests and some northern hardwoods. *1484, 2040, 3057, 3058, 3895, 3898, 4740; PWT L-1676, L-1678.*

A. sanguinea (Pursh) DC., (M, N). (O) Coastal forests. *2065, 3908, 4514, 4748; WRO 1390; PWT L-1552, L-1811.*

A. spicata (Lam.) K. Koch, (M). (O) Coastal forests. *WRO 318.*

Aronia prunifolia (Marshall) Rehder, Chokeberry (M, S, N). (F) Swales, bogs, and edges of lakes and streams. *2716, 2825, 3155, 3445, 4099; PWT L-186.*

Crataegus chrysocarpa Ashe, (N). (L) Bennens Clearing. *4792.*

C. holmesiana Ashe, (M). (L) Along Norcronk Rd. *3000, 3919.*

C. macrosperma Ashe, (M). (L) Along Lake Michigan Rd. east of Shalda Creek. *4715.*

C. punctata Jacq., (M). (L) Field along M-22 south of Empire. *PWT L-860, L-1252, L-1274.*

Fragaria vesca L., Woodland Strawberry (S, N). (L) Woods bordering Lake Michigan on Manitou Islands: near Weather Station campground, South Manitou; north of West Side, North Manitou. *1315, 4753.*

F. virginiana Miller, Wild Strawberry (M, S, N). (C) Old fields and some dunes. *1243, 1335 1472, 2039, 2190, 3910.*

Geum aleppicum Jacq., (M, S, N). (F) Lake edges, moist coastal forests, and northern hardwoods. *1748, 2013, 2417, 2455, 3394, 3424, 4088; PWT L-1319; Wislizenus 932.*

G. canadense Jacq., (M). (C) Northern hardwoods and some wet woods. *2353, 2412, 2456, 3514.*

G. rivale L., Water Avens (M). (O) Cedar swamps. *2262, 3272.*

Malus pumila Miller, Apple (M, S, N). (O) Persisting where planted, but occasionally an old field escape, especially on South Manitou. *1758, 1852, 2999, 3569, 3651.*

Potentilla anserina L., Silverweed (M, S, N). (O) Shores. *1381, 2448, 2579, 4326; WRO 463; Wislizenus 494.*

P. argentea L., Silvery Cinquefoil (M, S, N). (O) Old fields and roadsides. *1425, 1891, 2232, 2599; PWT L-90; EGV 5160; Wislizenus 493.*

P. fruticosa L., Shrubby Cinquefoil (M). (F) Swales, lake edges, and sedge mats. *2879, 2947, 4461; WRO 517.*

P. norvegica L., Rough Cinquefoil (S). (O) Swales and lake edges. *1521, 1800; PWT L-947.*

P. palustris (L.) Scop., Marsh Cinquefoil (M, S, N). (C) Swales, bogs, sedge mats, and lake edges. *1811, 2713, 4053; PWT L-1342, L-1700.*

P. recta L., Sulfur Cinquefoil (M, S, N). (C) Old fields and roadsides. *1339, 1667, 2319, 2385, 2432.*

P. simplex Michaux, (S). (L) Old field on South Manitou. *1560.*

Prunus mahaleb L., Perfumed Cherry (M, S). (F) Persisting where planted, but often an old field escape from cultivation. *1759, 3048.*

P. pensylvanica L. f., Pin Cherry (M, S). (F) Old fields. *1874, 2089, 2116, 2775; PWT L-70.*

P. pumila L., Sand Cherry (M, S). (C) Dunes. *1294, 2126, 2954; Engelmann; WRO 101, 572; EGV 9881.*

P. serotina Ehrh., Black Cherry (M, S, N). (C) Northern hardwoods of mainland and North Manitou; rare on South Manitou. *1826, 2741, 3646.*

P. virginiana L., Choke Cherry (M, S, N). (C) Old fields, coastal forests, and some northern hardwoods. *1306, 1774, 1825, 2760, 2912, 3566; WRO 309, 651; PWT L-112.*

Rosa acicularis Lindley, Wild Rose (M, S). (O) Dunes and some coastal forests. *1307, 3236; PWT L-1641.*

R. blanda Aiton, (M, S). (O) Coastal forests and some dunes. *1519, 2380, 2495, 4066, 4186; WRO 951, 1116.*

R. eglanteria L., Sweetbriar (N). (L) Shores of Lake Michigan, North Manitou. *1404, 1613.*

R. palustris Marshall, Swamp Rose (M, S). (F) Swales and edges of lake and streams. *1563, 1753, 2341, 2567, 2654, 4264; WRO 457, 1003.*

Rubus allegheniensis Porter, Common Blackberry (M, N). (O) Old fields. *1487, 3618.*

R. canadensis L., (N). (L) Bank west of dock at North Manitou Village. *4572.*

R. flagellaris Willd., Northern Dewberry (M). (L) Marl Springs and some swales. *2342, 3221.*

R. hispidus L., Swamp Dewberry (M). (F) Wet woods and moist fields. *3574, 4414, 4426.*

R. occidentalis L., Black Raspberry (M, S). (L) Old field along Pyramid Point trail and along trail west of schoolhouse, South Manitou. *1818, 3642, 4296.*

R. odoratus L., Flowering Raspberry (M). (L) North-facing bluffs near D. H. Day Campground. *2374, 4185.*

R. parviflorus Nutt., Thimbleberry (N). (L) North Manitou. *Wislizenus 929.*

R. pensilvanicus Poiret, (S, N). (L) South end of Lake Florence. *1322.*

R. pubescens Raf., Dwarf Raspberry (M, N). (O) Black ash swamps and cedar swamps. *2416, 3247, 4158, 4234, 4422.*

R. strigosus Michaux, Wild Red Raspberry (M, S, N). (F) Old fields and roadsides. *2566, 2638, 3530, 3556, 4317; Wislizenus 930.*

Sorbaria sorbifolia (L.) A. Br., False Spiraea (M). (L) Along Scenic Drive; profuse at Aral homesite. *3408; WRO 36.*

Sorbus decora (Sarg.) Schneider, Mountain-ash (M, S, N). (O) Northern hardwoods near Lake Michigan; edge of Otter Creek. *1392, 1777, 4434; PWT L-691.*

Spiraea alba Duroi, Meadowsweet (M, S). (O) Swales and lake edges. *1581, 2568, 4847.*

RUBIACEAE (Madder Family)

Cephalanthus occidentalis L., Button-bush (M). (L) Edges of Otter and Bass lakes (Leelanau Co.). *4469; PWT L-414, L-1263.*

Galium aparine L., Cleavers (M, S, N). (F) Northern hardwoods. *1237, 2051, 3255, 4140; WRO 568.*

G. lanceolatum Torrey, Wild Licorice (M). (O) Northern hardwoods. *2328, 2388, 3238.*

G. obtusum Bigelow, (M). (L) Otter Creek near Aral bridge. *WRO 593; PWT LB-2265.*

G. palustre L., (M). (O) Edges of lakes and streams. *2447, 2454, 4094; WRO 1237.*

G. pilosum Aiton, (M). (O) Jack pine stands and coastal forests. *2855, 2881, 3492; PWT LB-2317.*

G. tinctorium L., (N). (O) Black ash swamps. *1698, 1784, 2718, 4134.*

G. triflorum Michaux, Sweet Scented Bedstraw (M). (F) Northern hardwoods and cedar swamps. *1383, 1535, 2324, 3275; WRO 391; PWT LB-2290.*

G. verum L., Yellow Bedstraw (M). (L) Wet field along M-22 near Sutter Rd. *3227.*

Houstonia longifolia Gaertner, Bluets (M). (L) Coastal forests along Platte Bay. *2285; WRO 16; PWT LB-2314.*

Mitchella repens L., Partridgeberry (M, S, N). (F) Northern hardwoods and some cedar swamps. *1236, 2450, 2520, 4163; Wislizenus 531.*

SALICACEAE (Willow Family)

Populus alba L., (M). (O) Spreading from former home sites. *3180.*

P. balsamifera L., Balsam Poplar (M, S, N). (F) Dunes and shores. *1300, 1386, 2768, 3652; WRO 244; PWT L-176, L-1643.*

P. deltoides Marshall, Cottonwood (M, S). (F) Lake edges, old fields, and some dunes. *1313, 1358, 2382, 2777; WRO 1217; PWT L-65, L-279; EGV 1351, 2896.*

P. grandidentata Michaux, Big-tooth Aspen (M, S, N). (C) Young woods, old fields, and coastal forests. *1654, 1722, 2137, 3235.*

P. nigra L., Lombardy Poplar (M, S, N). (L) Persisting at, and spreading from, former home sites; some dunes. *1366, 1461, 2254, 3861; WRO 1281; EGV 5153.*

P. tremuloides Michaux, Quaking Aspen (M, S, N). (C) Old fields and coastal forests. *1626, 1817, 2778, 2826.*

Salix amygdaloides Andersson, Peach-leaved Willow (M, S). (L) Swales and lake edges. *4111; PWT L-418.*

S. bebbiana Sarg., Beaked Willow (M, S, N). (F) Swales and shores. *1625, 1990, 2079, 4054, 4063, 4105.*

S. candida Willd., Sage Willow (M). (O) Swales and lake edges. *2934, 3446.*

S. cordata Michaux, Sand-dune Willow (M, S, N). (F) Dunes. *1359, 1427, 1971, 2057, 2916, 4504, 4673; WRO 266, 308; PWT L-98; EGV 1013.*

S. discolor Muhlenb., Pussy Willow (M, S). (C) Wet fields, sedge mats, and lake edges. *3892, 3957, 4062, 4235; PWT L-188, L-1412.*

S. eriocephala Michaux, (M). (L) Wet fields and woods along Kelderhouse Rd. *3575, 3582.*

S. exigua Nutt., Sandbar Willow (M, S, N). (C) Dunes and shores. *1602, 1739, 2935, 4764; WRO 819, 1221; PWT L-416, L-671, L-916; EGV 5152.*

S. humilis Marshall, Upland Willow (M). (L) Edge of woods near Aral Rd. *2916.*

S. lucida Muhlenb., Shining Willow (M, S, N). (O) Lake edges, swales, and wet fields. *1862, 2018, 4061, 4093, 4112, 4146; PWT L-272.*

S. myricoides Muhlenb., Blueleaf Willow (M). (F) Dunes and shores. *2056, 2379, 3033, 3936; PWT L-273, L-417, L-704, LB-2259.*

S. pedicellaris Pursh, (M). (L) Edge of Hidden Lake. *PWT L-1411.*

S. petiolaris Smith, Slender Willow (M, S). (C) Swales and edges of lakes and streams. *1260, 1812, 2009, 2078, 3174, 3580, 4103, 4110.*

S. serissima (L. Bailey) Fern., Autumn Willow (M). (L) Swales east of Cooper Rd. *3447.*

SANTALACEAE (Sandalwood Family)

Comandra umbellata (L.) Nutt., Bastard Toadflax (M, S, N). (O) Coastal forests. *1717, 1984, 2270, 4761; Engelmann; WRO 431, 967.*

Geocaulon lividum (Richardson) Fern., (M, S). (L) Woods/dunes border near bay, South Manitou; jack pine stand, Aral Dunes. *1716; WRO 1891* (Collected by H. Gall).

SARRACENIACEAE (Pitcher-plant Family)

Sarracenia purpurea L., Pitcher-plant (M, N). (L) Bogs and some sedge mats. *2439, 2483; WRO 394; Wislizenus.*

SAXIFRAGACEAE (Saxifrage Family)

Chrysosplenium americanum Hook., Golden Saxifrage (M, N). (F) Cedar swamps and wet woods. *1855, 1985, 2160, 2480.*

Mitella diphylla L., Bishop's Cap (M, S, N). (F) Northern hardwoods. *1475, 1562, 2044, 2246; EGV 9906.*

M. nuda L., Naked Miterwort (M, S, N). (F) Cedar swamps and black ash swamps. *1566, 1672, 2098, 2233; EGV 9891A.*

Parnassia glauca Raf., Grass-of-Parnassus (M). (O) Stream edges and some cedar swamps. *2876, 4440, 4677; PWT LB-2344.*

Tiarella cordifolia L., Foam Flower (M). (F) Cedar swamps, black ash swamps, and some northern hardwoods. *2081, 2101, 2159, 3162, 3923; WRO 298.*

SCROPHULARIACEAE (Figwort Family)

Agalinis purpurea (L.) Pennell, Purple Gerardia (M, S). (L) Edges of Round Lake and Lake Florence. *1884, 4848; WRO 621.*

A. tenuifolia (Vahl) Raf., (M). (L) Along Crystal River. *PWT L-1883.*

Chelone glabra L., Turtle-head (M). (L) Along Platte River. *4722.*

Linaria canadensis (L.) Dumort., Blue Toadflax (M). (L) Open sites in coastal forest north of Platte River. *3167; WRO 317; PWT LB-2298.*

L. vulgaris Hill, Butter-and-eggs (M, S). (O) Old fields and roadsides. *1668, 2024, 2956; PWT L-455.*

Melampyrum lineare Desr., Cow-wheat (M, S, N). (F) Coastal forests. *1711, 2557, 3516, 4555; PWT L-368; WRO 110, 428.*

Mimulus glabratus HBK., Yellow Monkeyflower (M). var. *fremontii* (Benth.) A.L. Grant (L), Marl Springs. *3626; WRO 2677.* var. *michiganensis* (Pennell) Fassett, (R) Shore of Glen Lake near Inspiration Point. *4853.*

M. ringens L., Square-stemmed Monkeyflower (M, N). (L) Shore of Crystal River; outlet of Lake Manitou. *2541, 4531.*

Pedicularis canadensis L., Wood Betony (M, S, N). (F) Coastal forests and young woods. *1362, 2100, 2227, 4556; WRO 343, 566; PWT L-74, LB-2385.*

Scrophularia lanceolata Pursh, Hare Figwort (M, N). (O) Along trails and roads. *1651, 2411, 4184; WRO 1916.*

Verbascum blattaria L., (M). (O) Old fields and roadsides. *2465, 2530; WRO 1204.*

V. thapsus L., Common Mullein (M, S, N). (C) Old fields and roadsides. *1595, 2578, 2748; EGV 5163.*

Veronica americana (Raf.) Schwein., American Brooklime (M). (F) Cedar swamps, some trails, and edges of lakes and streams. *2489, 3924, 4178, 4209; WRO 966; PWT LB-2279.*

V. arvensis L., Corn Speedwell (M). (O) Disturbed ground and roadsides. *2105, 2097.*

V. longifolia L., (M). (L) Wet field near Tucker Lake. *4246.*

V. officinalis L., Common Speedwell (M, S, N). (O) Disturbed ground; along trails and roadsides. *1395, 1945, 2302, 2337, 2381, 2726; PWT L-1873.*

V. serpyllifolia L., (M, S, N). (O) Moist woods and fields. *1792, 1960, 2006, 2727; PWT L-402, L-1843.*

SIMAROUBACEAE (Quassia Family)

Ailanthus altissima (Miller) Swingle, Tree-of-heaven (M, S). (O) Persisting at, and spreading to old fields from, former home sites. *1791, 3467, 3533, 3557; WRO 2675.*

SOLANACEAE (Nightshade Family)

Physalis heterophylla Nees, Clammy Groundcherry (M, S, N). (F) Old fields. *1728, 2493, 2494, 3532, 4283, 4570; PWT L-1877.*

P. longifolia Nutt., (M). (O) Old fields. *2782, 2849; PWT L-653.*

Solanum carolinense L., Horse Nettle (M, S, N). (L) Old fields. *1671, 2540, 4311; PWT L-275.*

S. dulcamara L., Nightshade (M, S, N). (F) Old fields; swales and stream edges. *1804, 2620, 2932, 3254, 4135, 4174.*

S. nigrum L., (M, S). (O) Disturbed ground and roadsides. *2991, 3585, 3680, 4333.*

THYMELAEACEAE (Mezereum Family)

Dirca palustris L., Leatherwood (M). (O) Northern hardwoods, especially common in Bow Lake unit. *2351, 2909, 4737; WRO 666.*

TILIACEAE (Basswood Family)

Tilia americana L., Basswood (M, S, N). (C) Northern hardwoods. *1627, 1926, 2614, 2913.*

ULMACEAE (Elm Family)

Ulmus americana L., American Elm (M, S, N). (F) Northern hardwoods; some black ash swamps and other wet woods. *1520, 2904, 3040, 3187, 3507, 4541.*

U. rubra Muhlenb., Slippery Elm (M). (O) Northern hardwoods. *3633.*

UMBELLIFERAE [APIACEAE] (Parsley Family)

Aegopodium podagraria L., Goutweed (M). (L) Persisting at, and sometimes spreading from, old house sites. *3673; WRO 2503.*

Berula erecta (Hudson) Cov., Water-parsnip (M). (L) Marl Springs and a small spring feeding Otter Lake. *4714, 4819.* Michigan special concern species.

Cicuta bulbifera L., Water-hemlock (M, N). (F) Edges of lakes and streams. *4435, 4532, 4587; WRO 1513.*

Cryptotaenia canadensis (L.) DC., Honewort (M). (R) Disturbed ground along Greenan Rd. *4842.*

Daucus carota L., Wild Carrot (M, S, N). (C) Old fields and roadsides. *1509, 2553, 2644, 4803.*

Heracleum maximum Bartram, Cow-Parsnip (M, S, N). (F) Northern hardwoods. *1508, 2308, 3407; Wislizenus 501.*

Hydrocotyle americana L., (M). (L) Black ash swamp between School Lake and School Lake Rd. *4404.*

Myrrhis odorata Scop., European Sweet Cicely (M). (R) Roadside ditch near intersection of M-22 and Co. Rd. 651. *3256.*

Osmorhiza chilensis Hook. & Arn., (M, S, N). (O) Northern hardwoods and coastal forests of Manitou Islands, Glen Lake unit, and Good Harbor unit, especially on post-Nipissing lake plains. *1380, 1491, 1991, 2138, 4181, 4297.*

O. claytonii (Michaux) C. B. Clarke, Sweet Cicely (M, S, N). (C) Northern hardwoods. *1274, 1342, 1550, 1965, 2210, 2251; PWT L-931, L-1850; Wislizenus 517; EGV 9890A.*

Pastinaca sativa L., Wild Parsnip (M). (L) Roadside near intersection of Aral and Norcronk Rds. *2410.*

Sanicula gregaria Bickn., (M). (L) Marl Springs. *3244.*

S. marilandica L., (M). (O) Cedar swamps and some northern hardwoods. *2281, 2491.*

S. trifoliata Bickn., (M, S). (O) Northern hardwoods. *1768, 2497, 3508; PWT L-1789.*

Sium suave Walter, (M). (L) Shore of School Lake near inlet. *4460.*

Taenidia integerrima (L.) Drude, Yellow Pimpernel (M). (L) Coastal forests. *WRO 1408; PWT L-478.*

URTICACEAE (Nettle Family)

Boehmeria cylindrica (L.) Sw., False Nettle (M). (F) Swales and lake edges. *2639, 4366, 4682.*

Laportea canadensis (L.) Wedd., Wood Nettle (M). (O) Northern hardwoods. *2527a, 2973.*

Pilea pumila (L.) A. Gray, (N). (O) Northern hardwoods trails. *4536.*

Urtica dioica L., Stinging Nettle (M, N). (F) Wet sites near lakes and streams; some fields and roadsides. *1844, 2660, 2903, 3002, 3025, 4528, 4793; WRO 248.*

VERBENACEAE (Vervain Family)

Verbena bracteata Lagasca & Rodriquez, (M, N). (L) Garden plot, North Manitou Village. *1450.*

V. hastata L., (M). (O) Old fields and roadsides. *2948, 4809.*

V. simplex Lehm., (M). (O) Roadsides. *2498.*

V. stricta Vent., Hoary Vervain (M, S, N). (O) Disturbed ground and roadsides. *1710, 2458, 2546, 3430, 4804; PWT L-943.*

VIOLACEAE (Violet Family)

Viola adunca Smith, (M, S). (F) Open sites. *2001, 2066, 2141, 3030; WRO 561, 595; PWT LB-2445.*

V. affinis Le Conte, (M, S). (O) Cedar swamps and some northern hardwoods. *4049, 4751.*

V. arvensis Murray, Field Pansy (M, S). (O) Old fields and some disturbed sites. *2434, 3043, 3157, 3216.*

V. blanda Willd., Sweet White Violet (S, N). (O) Cedar swamps and wet woods. *1942, 1973, 1986.*

V. canadensis L., Canada Violet (M, S, N). (C) Northern hardwoods. *1326, 1970, 2030, 2053; WRO 40; PWT L-143, L-945; EGV 5121, 9897; Wislizenus 463.*

V. conspersa Reichb., Dog Violet (M, S, N). (C) Cedar swamps, black ash swamps, moist northern hardwoods, and some coastal forests. *1947, 1966, 2008, 2073, 2090, 3922, 4759.*

V. cucullata Aiton, Marsh Violet (M). (F) Cedar swamps and wet woods. *2110, 2192; PWT L-162.*

V. mackloskeyi F. Lloyd, (M, N). (O) Cedar swamps. *2243; PWT L-47, L-1580.*

V. nephrophylla E. Greene, (M). (L) Cedar swamp at Marl Springs. *2099.*

V. pubescens Aiton, Yellow Violet (M, S, N). (C) Northern hardwoods. *1481, 1941, 1969, 2052, 2247; WRO 570; PWT L-935, L-944; EGV 9889A.*

V. renifolia A. Gray, (M, S). (L) Coastal forest near Garden City cemetery, South Manitou. *1948, 2071.*

V. rostrata Pursh, Long-spurred Violet (M, S, N). (F) Northern hardwoods. *1979, 2010, 2072, 2131, 4746; PWT L-954; EGV 9888A.*

V. selkirkii Goldie, Great-spurred Violet (M, S, N). (O) Northern hardwoods and coastal forests. *1501, 1547, 1974, 4780.*

V. sororia Willd., (M). (L) Open site in coastal forest along M-109 east of D. H. Day Campground. *2082.*

VISCACEAE (Mistletoe Family)

Arceuthobium pusillum Peck, Dwarf Mistletoe (M). (L) M-22 bog. *3218; PWT L-1128.*

VITACEAE (Grape Family)

Parthenocissus quinquefolia (L.) Planchon, Virginia Creeper (M). (O) Northern hardwoods, coastal forests, and some roadsides. *2843, 2928, 4429.*

Vitis riparia Michaux, Grape (M, S, N). (C) Dunes. *1773, 1829, 2256, 2758; PWT L-926.*

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REVIEW

MANUAL OF VASCULAR PLANTS OF NORTHEASTERN UNITED STATES AND CANADA. Second Edition. By Henry A. Gleason and Arthur Cronquist. New York Botanical Garden, Bronx, NY, 10458. 1991. lxxv + 910 pp. $69.00.

When I reviewed the first edition of this manual (Michigan Bot. 2: 61–62. 1963), I predicted that "it will prove to be excellent for identification." Now, what can I say? "I told you so—and the new edition is even better!" Having used "G&C" for more than 10 summers in my field course at the U-M Biological Station, I would be the first to admit noting that it had some problems, including certain species that would key with difficulty if at all. Most of those problems have been cured in the new edition, and I hope that additional ones have not been added. But a lot else *has* been added: species newly recognized in the area, updating of taxonomy and nomenclature, more complete statements of geographic distribution, more thorough descriptions of taxa at all ranks, a list of frequently cited authors of scientific names, more terms in the glossary, and a map on the endpapers showing the geographic area covered.

A great deal of new and improved information on plant distribution has obviously been taken into account in preparing this very thorough revision. Nevertheless there are some surprising slips here and there. In my previous review I noted the clear absence of Michigan from the stated distribution of *Knautia arvensis,* 'scabiosa,' locally well naturalized in the Upper Peninsula and thus reported (1957) in a journal published by the New York Botanical Garden; but the new edition still has it far from this state. Similarly, *Agoseris glauca,* reported at the same time from the jack pine barrens of the Lower Peninsula, later placed on Michigan's list of threatened species and (in 1982) the subject of an article in this journal, is still not allowed to range into Michigan. *Listera auriculata,* a twayblade orchid, is still restricted in the state to Isle Royale despite the previous review, although it was recorded from the Lake Michigan basin in 1957. Maybe there will be a third edition . . . .

Other geographic problems involving this region and for which the facts have been clearly published concern *Iris lacustris,* for which there is no reliable evidence of occurrence on Lake Superior; *Elymus* [now *Leymus*] *mollis* (a handsome dune grass on Lake Superior), which is not known from Lakes Michigan and Huron (all previous reports having been corrected in print as misidentifications); *Prunus alleghaniensis,* a fine wild plum, which thrives in Michigan, the type locality of a named variety, although the

manual still does not let it get near; 'trail plant,' *Adenocaulon bicolor,* still credited to Minnesota although no documentation can be found, while omitted from Ontario, for which there *is* an old specimen from the Bruce Peninsula. For *Erigeron hyssopifolius,* a pretty little boreal fleabane, officially threatened in Michigan, there is no clue that it ranges south to flourishing colonies near the Straits of Mackinac (see Michigan Bot. 23: 14–16. 1984) or even to rock crevices along Lake Superior in Ontario. (In fact, the Ontario shore of Lake Superior is excluded from the range of this manual and hence is rarely mentioned. Under the devil's club, *Oplopanax,* (which, like *Panax*, is not given the gender required by the Code) there is a reference to Isle Royal [sic: still misspelled] "and adj. s. Ont." which is misleading to everyone who knows that area as *n.* Ontario.) Additional species recorded from Michigan (e.g. in *Michigan Flora*) but for which the stated range would clearly exclude this state, include *Torilis nodosa* (in fact mysteriously omitted completely from this edition), *Scleranthus perennis, Sedum sexangulare, Ranunculus lapponicus, Hypericum sphaerocarpon, Viola primulifolia, Proserpinaca pectinata, Rubus acaulis, Littorella uniflora, Chelone obliqua, Hieracium flagellare, Myriophyllum alterniflorum, Subularia aquatica, Potamogeton pulcher, P. confervoides* (better in first edition!), *Juncus stygius*, and *Eleocharis atropurpurea.*

On the other hand, a considerable number of species fairly recently recognized in Michigan are happily attributed to the state, such as *Quercus shumardii, Epilobium parviflorum, Bartonia paniculata, Ludwigia sphaerocarpa, Chenopodium aristatum, Gypsophila scorzonerifolia, Viola palustris (epipsila), Draba glabella, Erysimum hieraciifolium, Hedysarum alpinum, Ampelopsis brevipedunculata, Veronica verna, Cerastium pumilum, Astragalus cicer, Solidago sempervirens, Lactuca muralis, Scleria reticularis, Carex bushii, C. assiniboinensis, C. heleonastes, C. wiegandii, Muhlenbergia asperifolia, Corynephorus canescens,* and *Wolffia papulifera.* Briefly mentioned from the state but not keyed are *Dianthus carthusianorum* (but oddly not *D. sylvestris*), *Rumex thyrsiflorus,* and *Stellaria pallida. Geum urbanum*, which is taking over Ann Arbor, rates only two lines of text and no key; and *Allium rotundum*, established in several Michigan counties, is nowhere mentioned. (Readers of *The Michigan Botanist* may note with satisfaction that *most* of the discoveries reported in this journal have been taken into account—in which respect Michigan probably fares much better than, say, Kentucky in the updating of this manual.) It is also a pleasure to see that the ranges of a few species attributed to Michigan in the past but without specimen evidence are finally excluded from the state, such as *Trollius laxus, Silene drummondii, Perideridia americana,* and *Juncus longistylis.* Some species that *are* attributed to Michigan appear unnecessarily restricted to "n" or "s" parts of the state.

Of course some recent discoveries in field and herbarium (published thus far, at best, only as officially "threatened" or "endangered") would not be expected yet in the manual, e.g. *Rhexia mariana, Utricularia radiata,* and *U. subulata,* in the southwestern Lower Peninsula; *Vaccinium cespitosum, Asclepias ovalifolia,* and *Scutellaria* ×*churchilliana* in the Upper Penin-

sula; *Festuca gigantea* in the Sleeping Bear Dunes National Lakeshore. In an area of active floristic study, nothing remains complete for long!

Houghton's goldenrod (*Solidago houghtonii*) is allowed "mostly less than 50 heads," which is an improvement over the old number of 15, but still short of the truth, which is 200; and one of its presumed ancestors is now included in the same genus, as *S.* [formerly *Aster*] *ptarmicoides*. Other species of particular local interest include Pitcher's thistle (*Cirsium pitcheri*), now explicitly allowed to be sometimes a "monocarpic perennial"; *Lilium michiganense*, now recognized as a distinct species; a blue-eyed grass originally described from Michigan, *Sisyrinchium strictum,* moved from the synonymy of *S. montanum* to that of *S. atlanticum,* an even less likely place for it in my opinion. The beach pea is called *Lathyrus maritimus* (L.) Bigelow, a step onto nomenclatural thin ice, for Bigelow in 1824 explicitly indicated that his *Lathyrus maritimus* was *not* the *Pisum maritimum* of Europe—and Bigelow's new name therefore does not have priority over the earlier *Lathyrus japonicus* for the species.

The sequence of families in the manual now follows the "Cronquist system," for which synopses in key format are provided after the usual artificial keys to family. There are also countless less dramatic innovations that will be more or less unfamiliar to students of the local flora, and a few can be cited to indicate the broad scope of revision and the alterations made (I hesitate to call these *all* improvements, although most surely are). Fruit color has been added for leatherwood (*Dirca*)—and not the "red" so often and erroneously stated! *Cynoglossum boreale* is included in *C. virginianum* (following Cooperrider) and *Lindernia anagallidea* is included in *L. dubia*—a more justifiable merger, I think. *Phryma* is included in the Verbenaceae, as done by most authors these days. *Rhus* and *Toxicodendron* are both recognized, with two species of poison-ivy in the latter: *T. radicans* and *T. rydbergii;* the hybrid between *R. glabra* and *R. typhina* indeed "has been called *R.* ×*boreale*" but the alleged authorship and application of that name are, I believe, erroneous. The application of *Oxalis stricta* will, apparently, forever cause confusion, Cronquist using it for what has by some authors been called *O. fontana,* a name not even cited in synonymy. *Gerardia* has finally been recognized as discarded (as it was in 1959), replaced by *Agalinis* and *Aureolaria.*

Among the recent work evidently followed is that of Duncan on the *Ranunculus hispidus* complex, Mitchell on the *Polygonum amphibium* complex, Furlow on *Alnus,* Uttal on *Aronia,* Raven et al. on *Oenothera* (with a little lumping), and Marcks on the relatives of *Cyperus houghtonii.* However, *Euphrasia* does not follow Yeo; of the three species I recognize in Michigan, none are accepted: one (*E. hudsoniana*) is not even in synonymy; *E. disjuncta* is cited for Michigan, but our specimens so labeled are referable to *E. nemorosa*, which is cited in the synonymy of *E. officinalis;* and the third, the introduced and aggressive *E. stricta,* is lumped in the same synonymy. Some of the recent segregates in *Spiranthes* are recognized, and even fewer in *Botrychium. Solidago spathulata* has fallen to *S. simplex* ("HBK" i.e. in fact Kunth) and the former name, used in the first edition, is

not even cited in synonymy (although the also widely known *S. racemosa* still is—and still with Greene's name misspelled). *Eriophorum angustifolium* has been replaced by *E. polystachion,* and *Juncus balticus* by *J. arcticus,* neither change derived from either *Flora Europaea* or the Kartesz and Kartesz checklist (which have obviously inspired some changes—or at least reflect a common ancestry). Less jolting is inclusion of *Eriophorum spissum* as a variety of *E. vaginatum. Cyperus bipartitus* for what we have long known as *C. rivularis* will also upset those to whom name changes come hard.

However, compared with what *might* have been done, the number of names altered from those in the previous edition, whether for nomenclatural or taxonomic reasons, is not overwhelming. A number of genera are still treated in a broad sense, such as *Lycopodium, Arenaria, Euphorbia, Satureja, Panicum, Orchis,* and *Habenaria. Bidens* still includes *Megalodonta* despite defense of the latter by Roberts. The previous treatments of *Amelanchier* and *Crataegus* are practically unchanged except for minor updating, and even *Rubus* is very little altered although a partial list of putative hybrids has been added. There are only two more species of *Taraxacum.* Although Cronquist (the confessed author of the revision) is more inclined to lump than to split, there are some divisions. For example, *Polygala verticillata* has become two species, both in Michigan. Continuing to maintain both *Stachys hispida* and *S. tenuifolia* is a questionable distinction. The nomenclature of *Salix* seems up to date, but the key to species is very difficult, requiring for some species that one have in hand staminate plants, pistillate plants, *and* mature foliage—and know that these specimens are all from the same species (one who can make such connections probably doesn't need the key anyway). The grass family has been thoroughly remodeled, with no mention of subfamilies and tribes, a new sequence of genera, and a wholly new key to them. Fortunately, whether genera have been rearranged (as around *Elymus* and *Agropyron*) or not doesn't make consultation so difficult for the user when related taxa remain close together. (An alphabetical sequence can be frustrating when one fails to find an expected species in the genus sought—or anywhere near it, or doesn't know whether to seek indian-pipe (*Monotropa*) in the Ericaceae, Pyrolaceae, or Monotropaceae.)

Those of us who may be thought to have a pathological obsession with nomenclature are expected to quibble over "trivia." Besides the points mentioned above, I regret that space is left between the times sign and the epithet in binomials for hybrids (contrary to Rec. H.3A of the Code); the poor dandelion is maltreated in that the generic name is attributed to one author and the species name (*Taraxacum officinale*) to another, although both were published in the same work (and should be attributed to Weber); the unicorn plant, *Proboscidea louisianica,* is misspelled (see the correction from "*louisiana*" on the very last page of the work in which it was published); *Smilax ecirrata* is still misspelled; *Nemopanthus mucronatus* and *Vaccinium ovalifolium* are attributed to the wrong authors; *Agastache scrophulariifolia* has the wrong connecting vowels (*-iae-*); *Strophostyles*

helvula is misspelled (see Brittonia 38: 357). *Silene csereii*, not a rare species though barely mentioned in passing, is furthermore misspelled (if the man's name was Cserei, then adding the obligatory single *i* should produce *csereii*). The bandwagon is joined that replaces *Juncus alpinus* with *J. alpinoarticulatus,* although the latter is in a form that should be treated as not validly published under the Code (Art. 26.3d) On the other hand, *Nuphar variegata* now has the right gender and author; *Amphicarpaea* is at last spelled as conserved long ago; *Triglochin* has been corrected to neuter. There is a list of 19 nomenclatural innovations (not errors!) preceding the index.

Typographical errors cause pleasure to some who find them, and such persons (as the undersigned) could not fail to find a few in 1000 pages of mostly very fine print (smaller than in ed. 1). Overall, errors seem remarkably few for a work of this size and detail. One of the more interesting ones is the "dropping" leaves (perpetual autumn?) of *Acalypha ostryaefolia*—which, besides, should be *ostryifolia*. *Scirpus frontinalis* and *Carex synchnocephala* look pronounceable—but are wrong (the latter is o.k. in the index). Contrasting "Cor-lobes" with "Cal-lobes" (couplet 3, p. 425) occurs on the same page as misspelling of *caroliniense*.

Improvements in the keys are numerous throughout. *Sorbaria* has been moved from the herbaceous to the woody side of the key to genera of Rosaceae, where *Potentilla fruticosa* will now fortunately also key down. All keys, including the General Keys at the beginning, are now strictly dichotomous and both contrasting leads in each couplet now bear matching numbers, making accurate use much easier. Most keys have been more or less remodeled, and there is one more section in the General Keys (so don't rely on remembering the old numbers for sections!).

Is this volume worth the investment (± 6 times the original price of the first edition)? Yes, indeed—so long as you remember that its function is to aid *identification*. The keys are well constructed, the descriptions more ample than in the first edition, the glossary exceptionally well written (though some unusual terms employed, such as cordulate and bistratal, are not there), the additional remarks oriented toward definition and recognition of taxa. But habitats are stated with extreme brevity, there is very little if any information on aspects like life histories or pollination, and there are no references whatsoever to additional literature such as monographs, revisions, illustrations, or other manuals useful in some parts of the region (only a single reference to the reviser's own *Evolution and Classification of Flowering Plants,* the basis for the modern arrangement of families used). Even for identification, the rank beginner faces a formidable task because there is no introduction to the use and interpretation of keys, the nature of taxonomy and taxonomic categories, the principles of nomenclature and author citations, or even some of the shortcuts used in the text (such as measurements representing length or height when not otherwise specified). As in learning to use a computer, a good teacher (not necessarily a professional) will be an immensely helpful timesaver for accessing the enormous potential available. This revised edition has 125 more pages than the first,

and is packed with information. Another revision is quite unlikely for a long time to come. Book prices rarely go down. Grit your teeth and get this one while it's still fresh and quite up to date. Then *use* it, and maybe you'll not have to call on someone else so often to answer your questions about the flora of northeastern North America.

—Edward G. Voss
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On the cover: *Sleeping Bear, looking northward from Empire Bluffs. Photographed by Brian T. Hazlett.*